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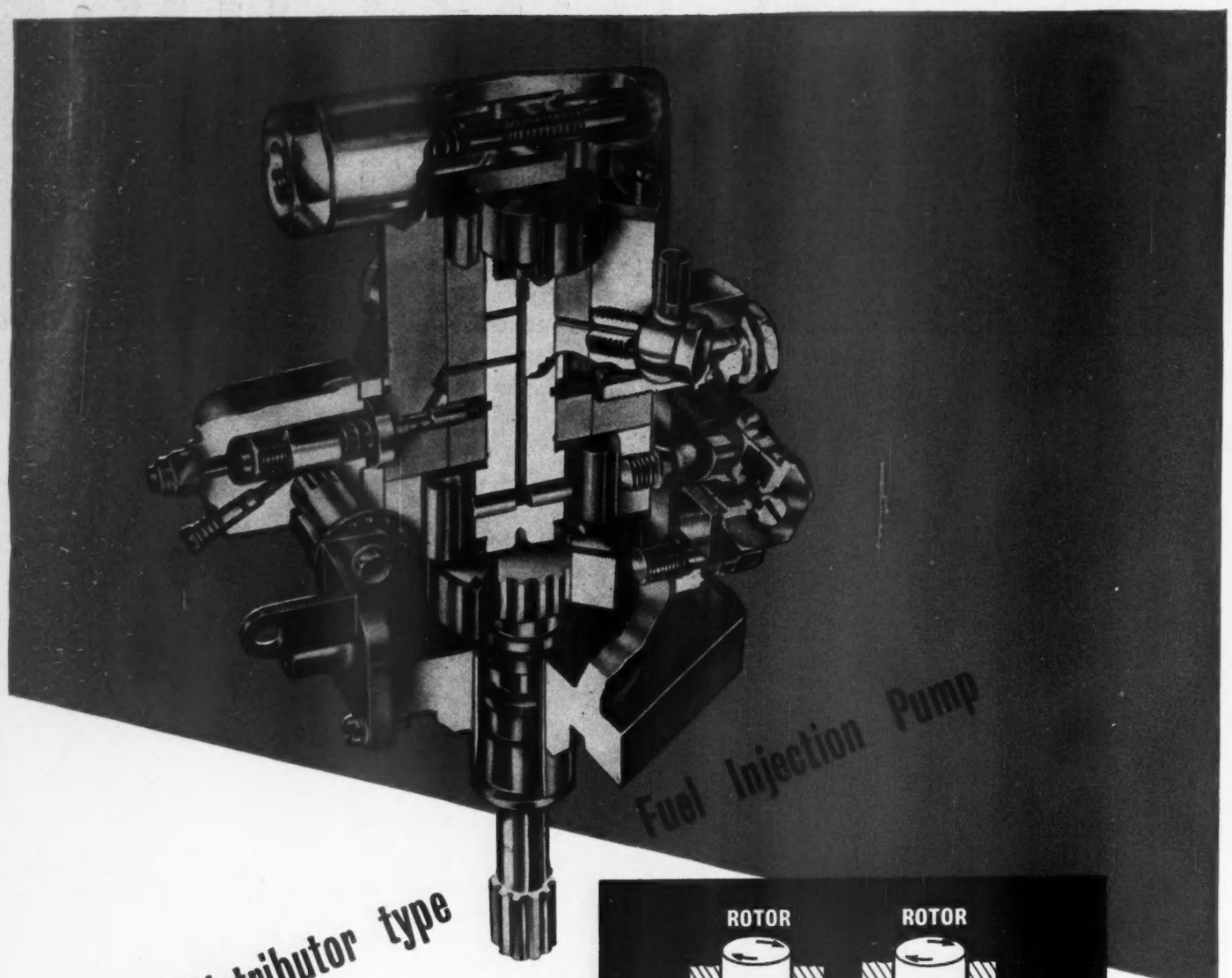

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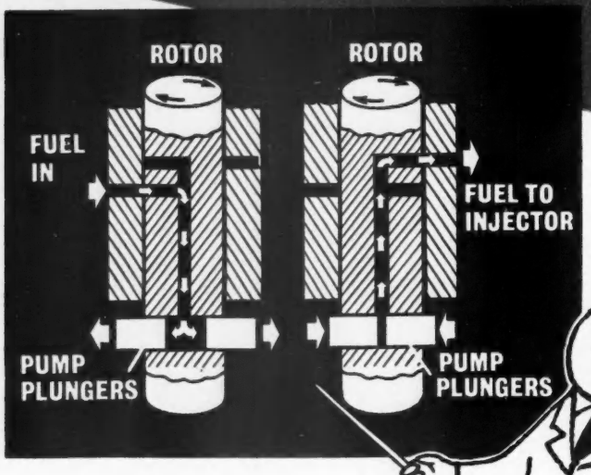

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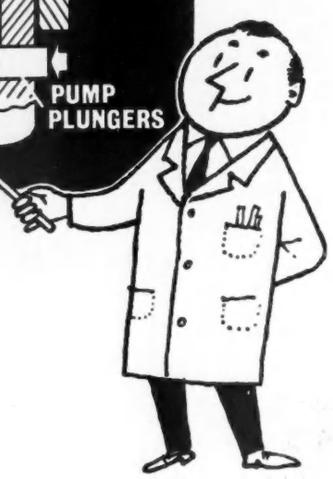

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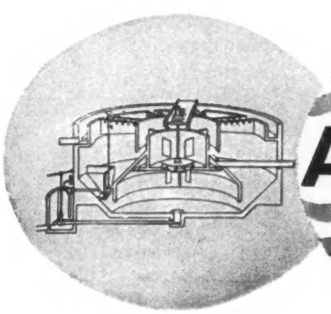

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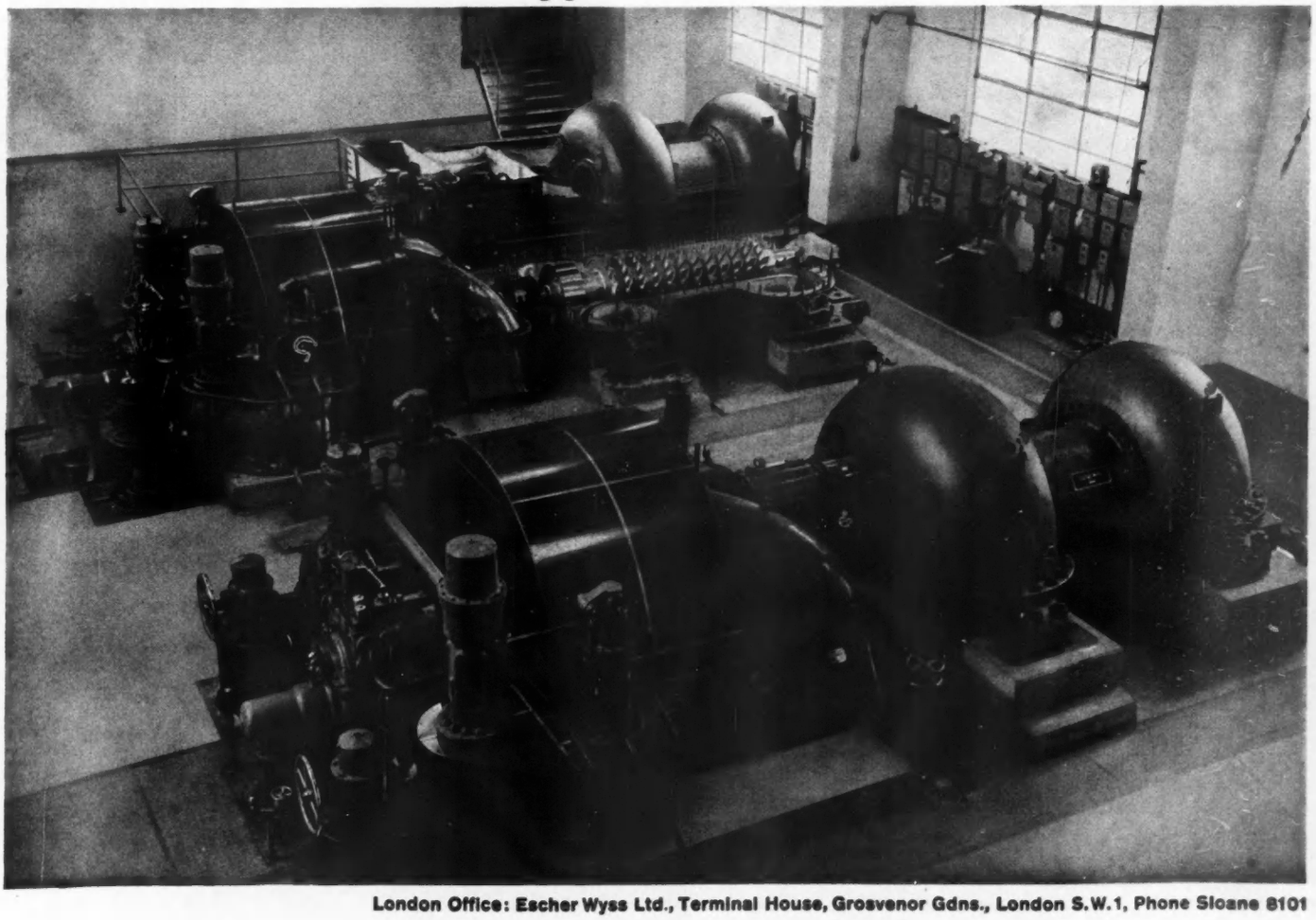

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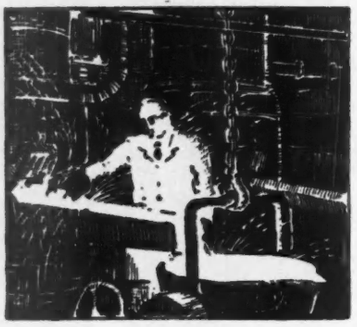

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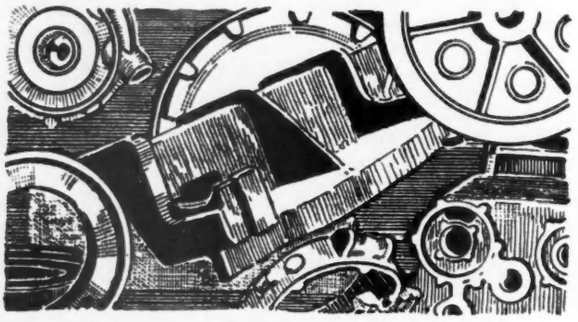

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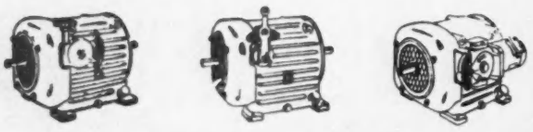

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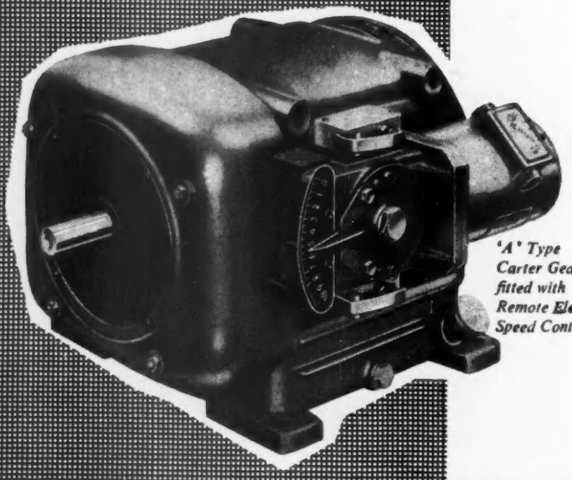

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Calibration of the nozzles used in the combustion chamber of an aircraft gas-turbine. Each nozzle is calibrated for spray angle and quality of spray in relation to a master nozzle. (*Nurnberg photograph for* ENGINEERING.)

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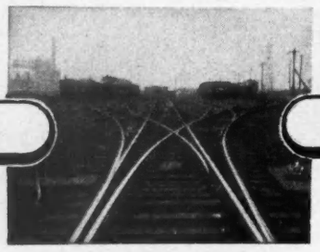

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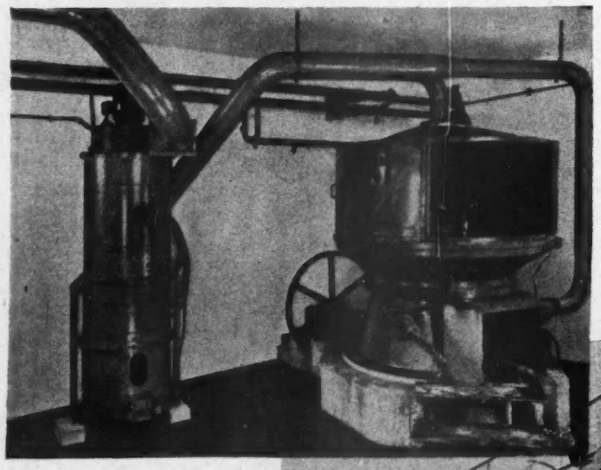

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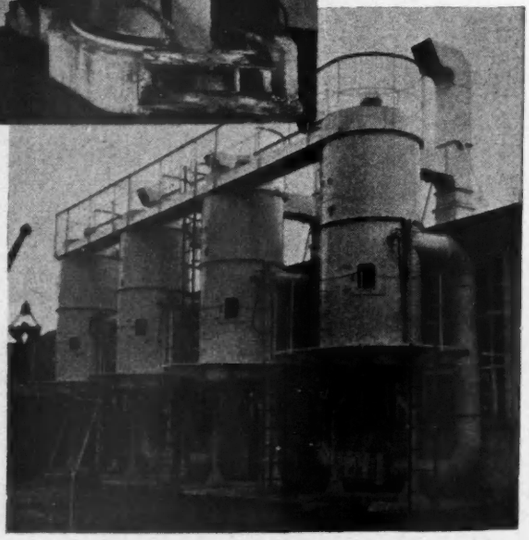

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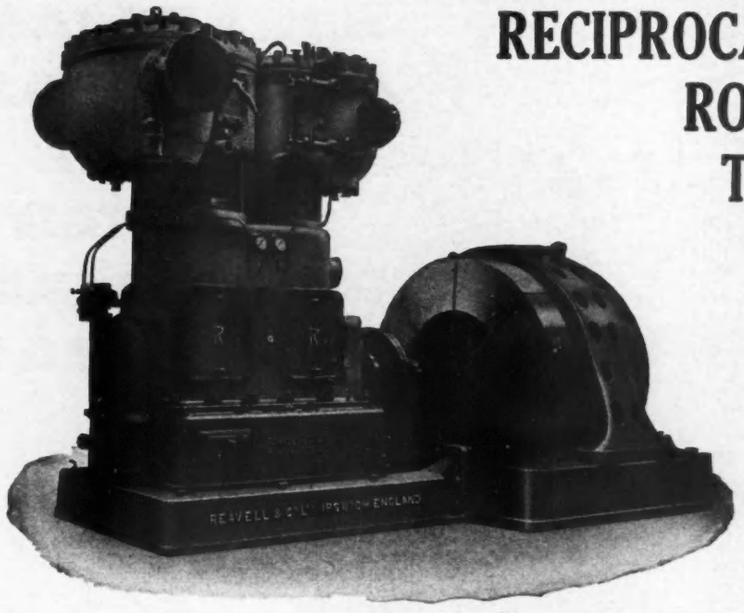

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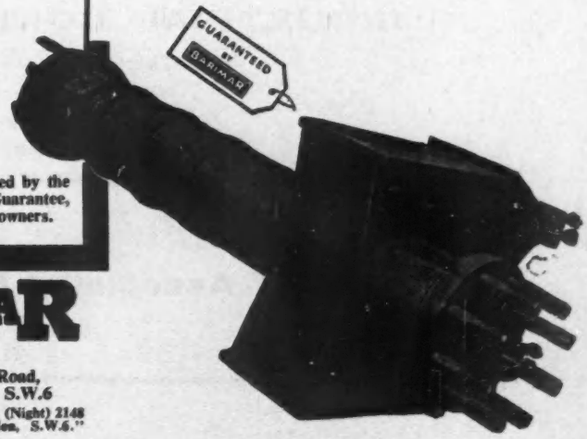

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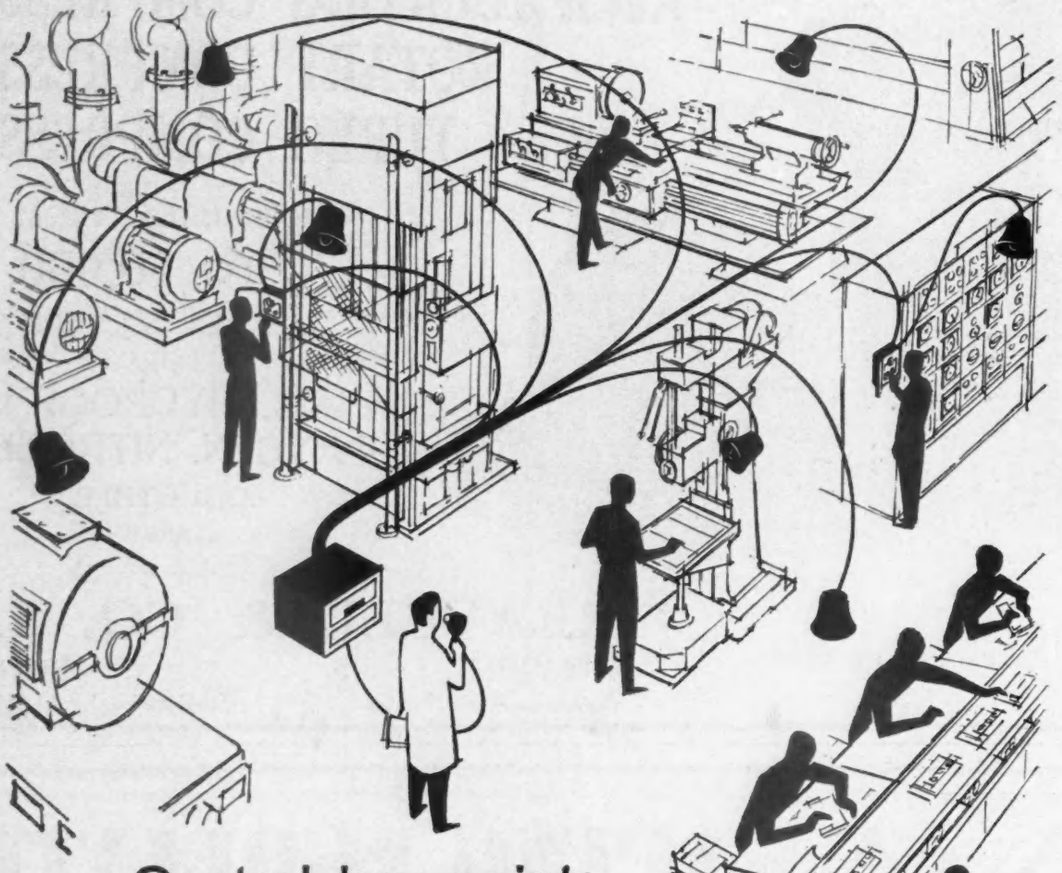

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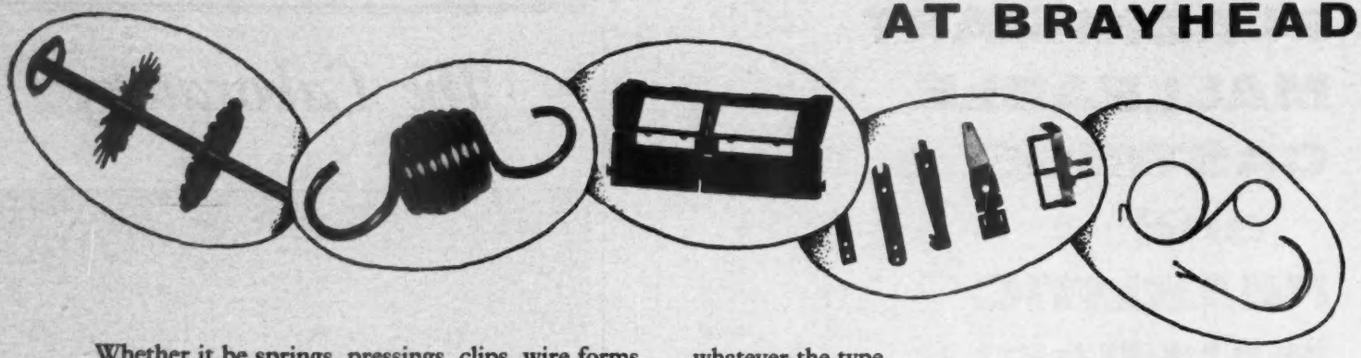

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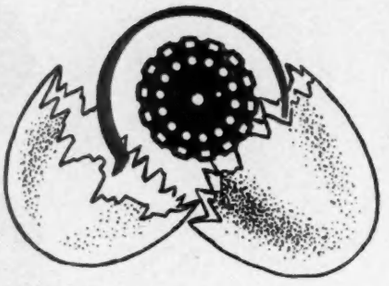

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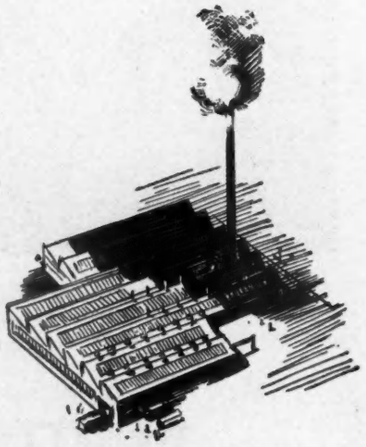

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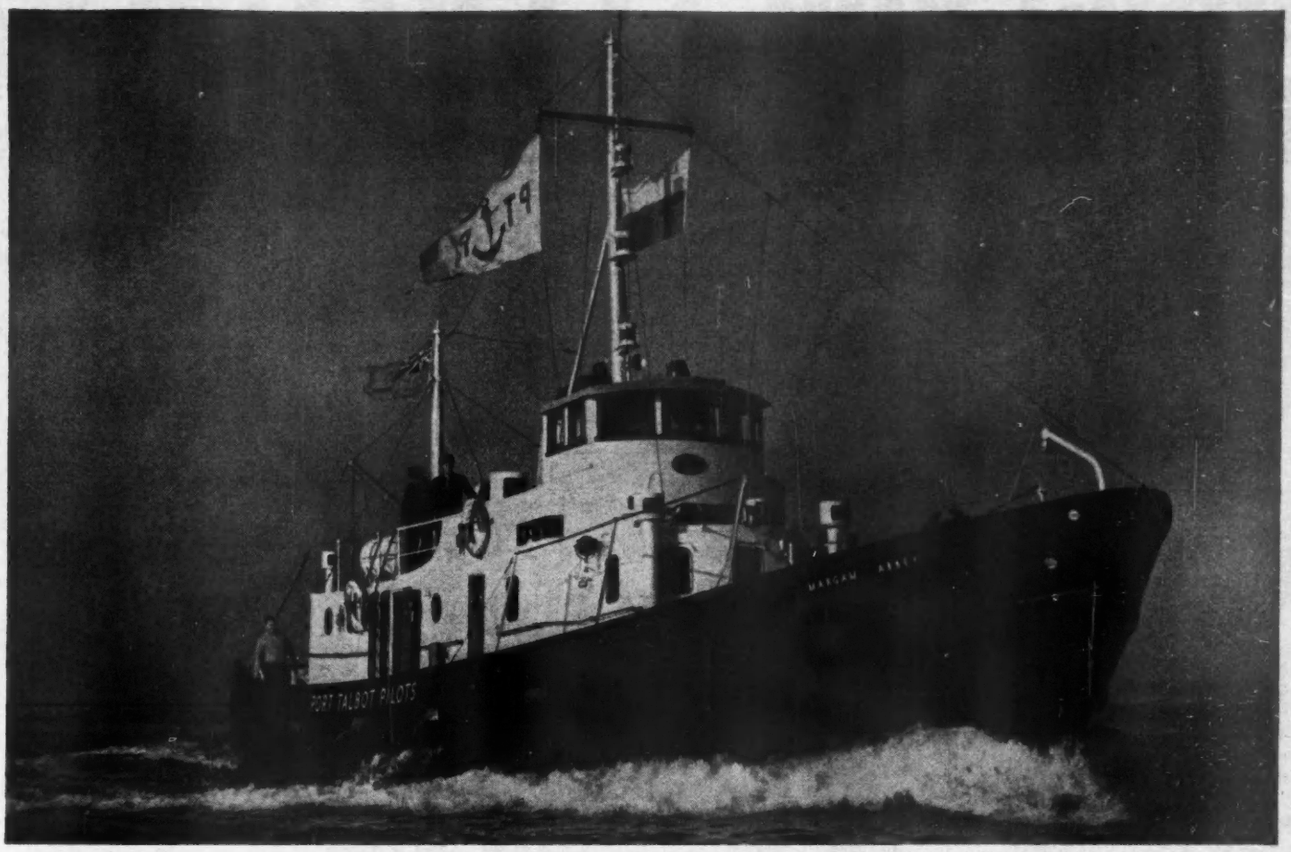

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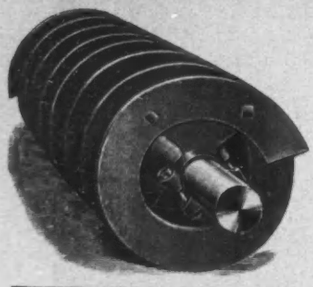

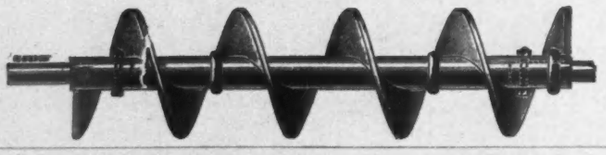

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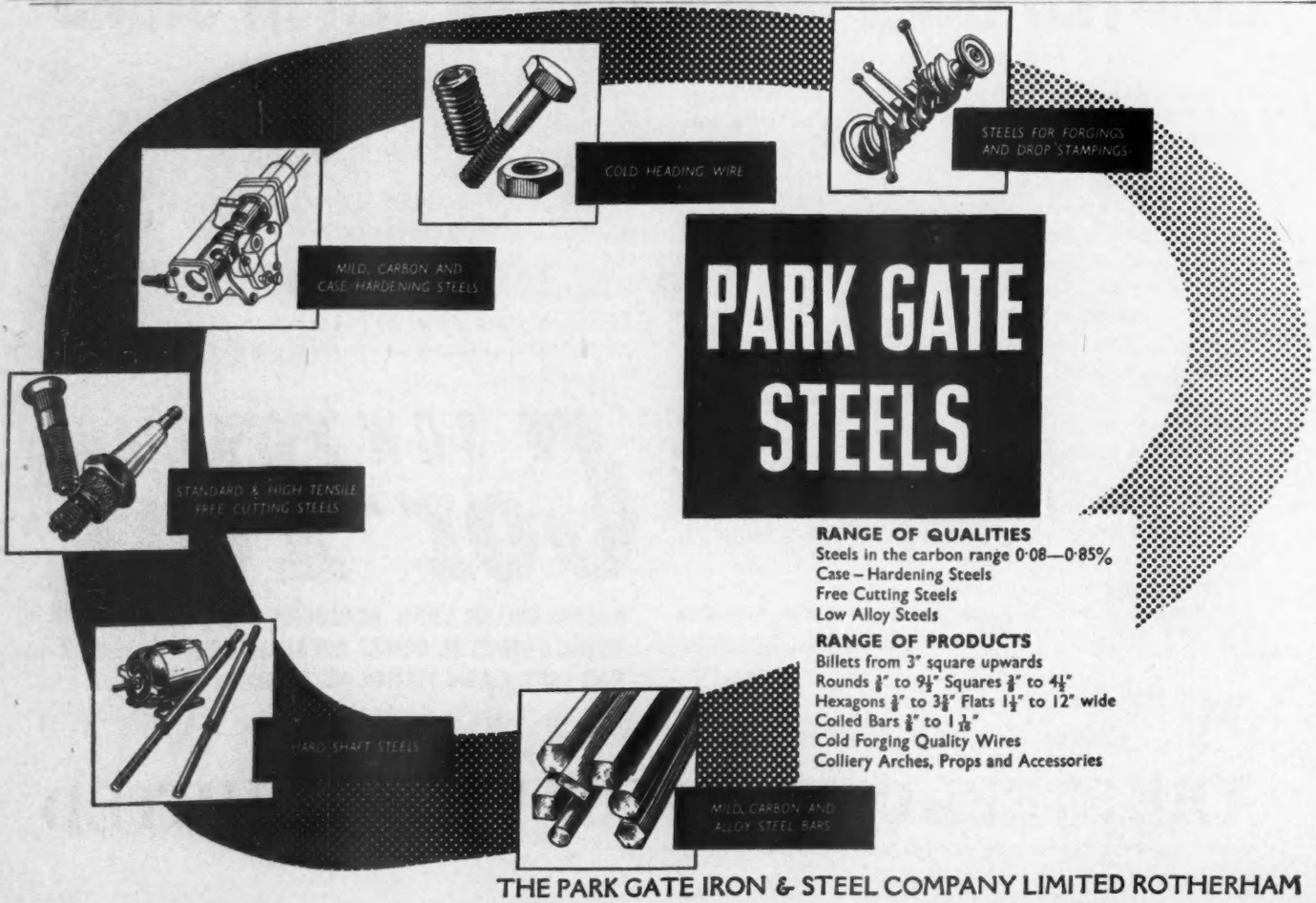
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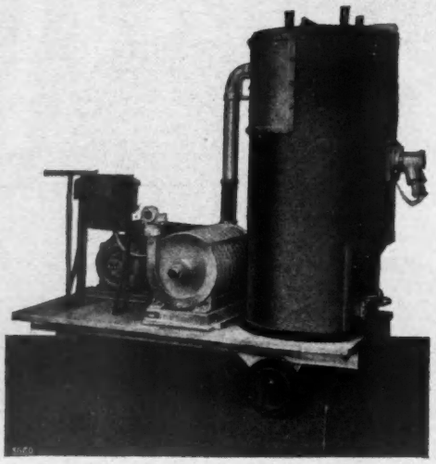

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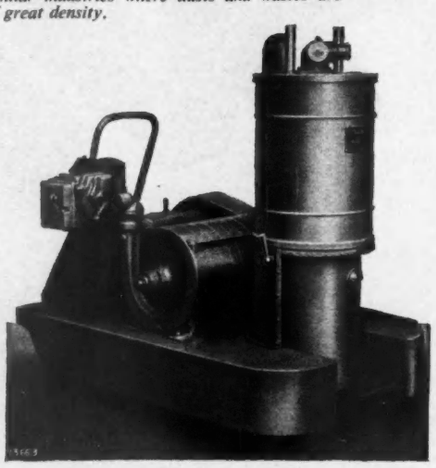

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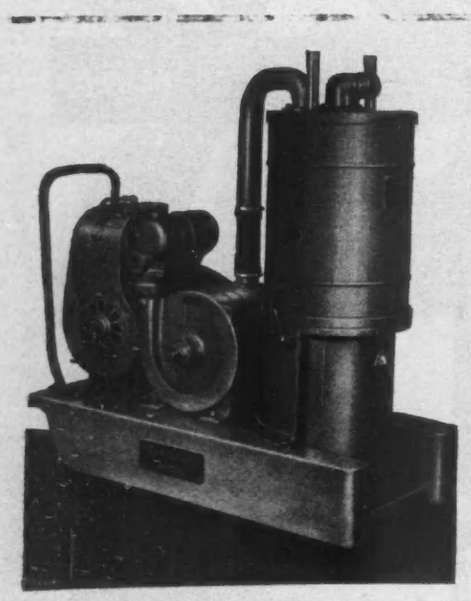
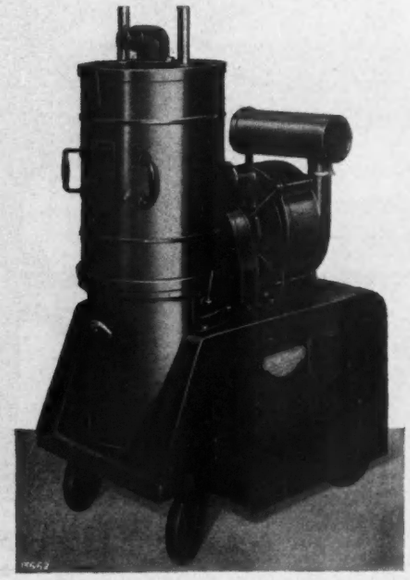


A Sturtevant 6X Portable cleaner, driven by a petrol engine.



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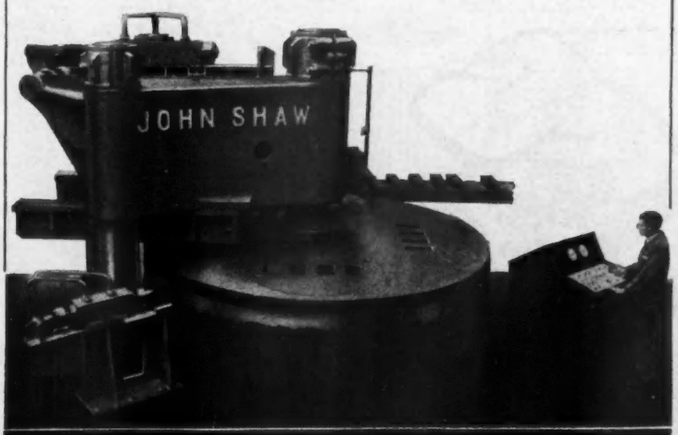

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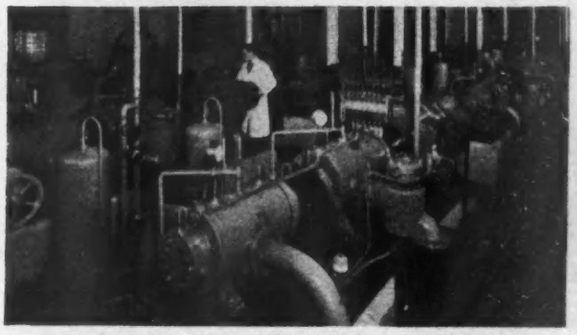

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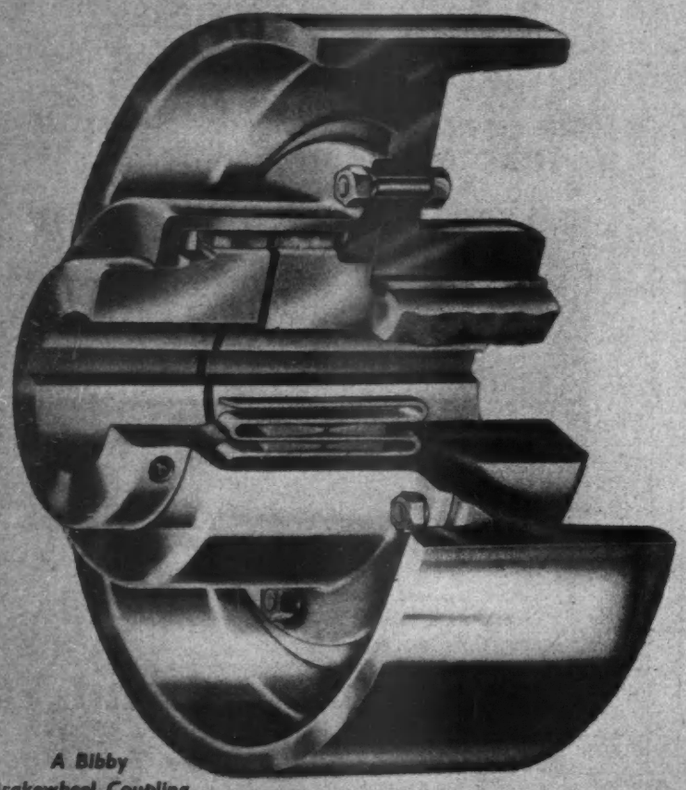

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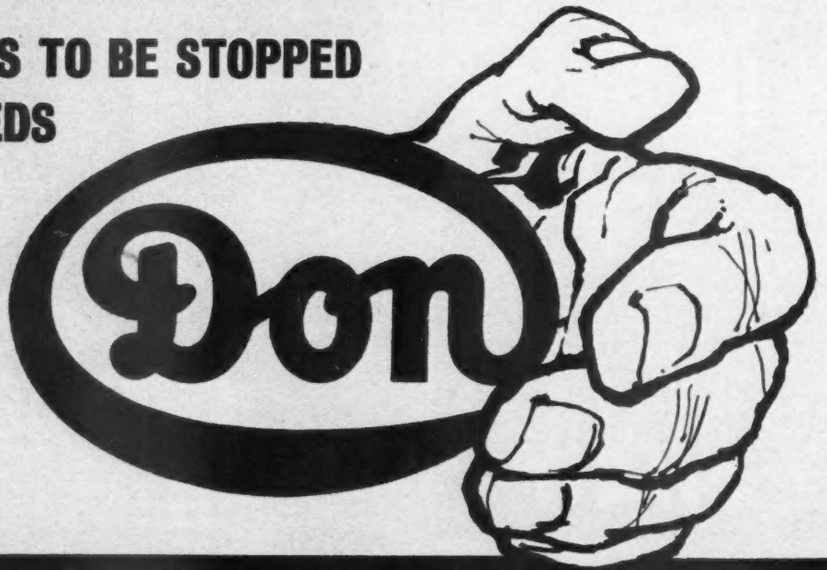

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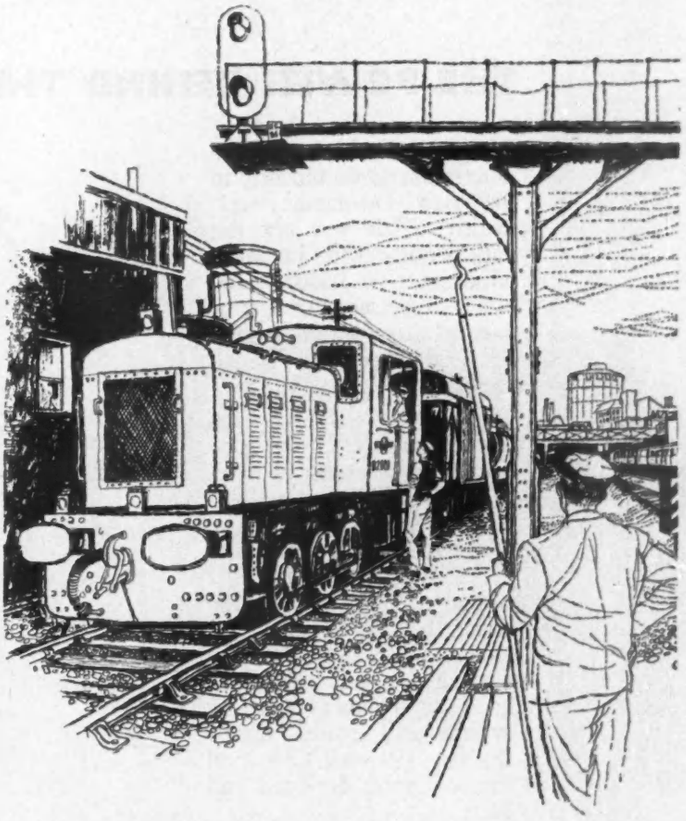

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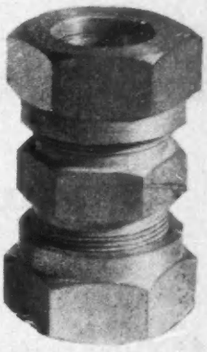

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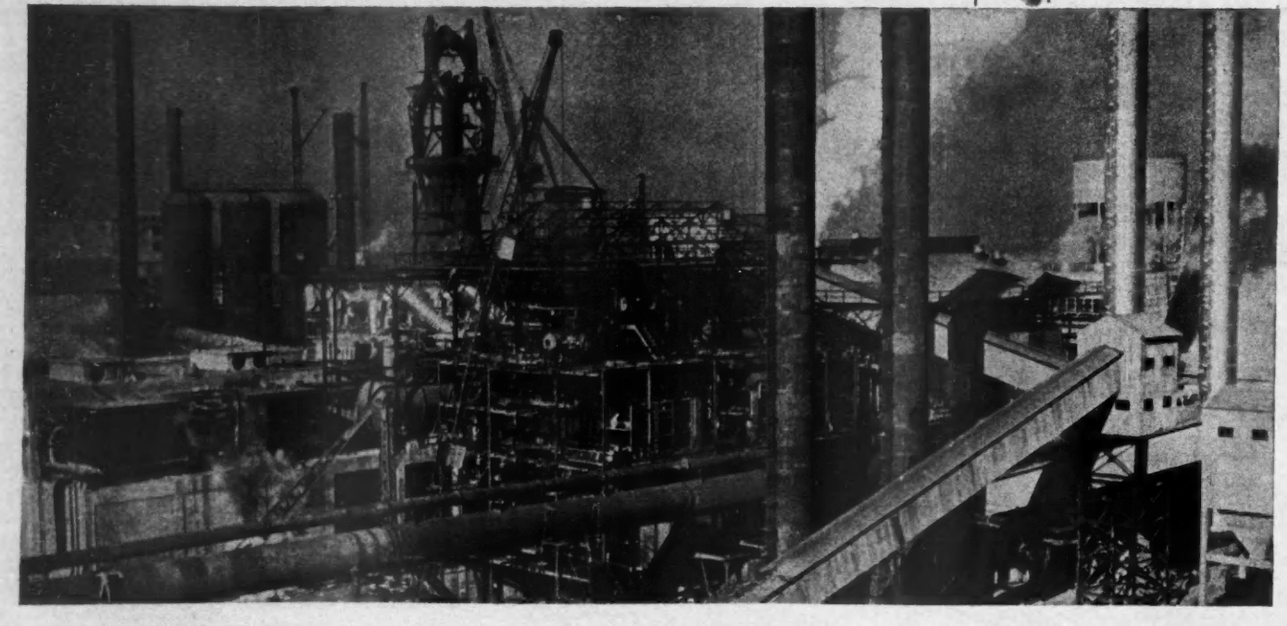

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SC 235

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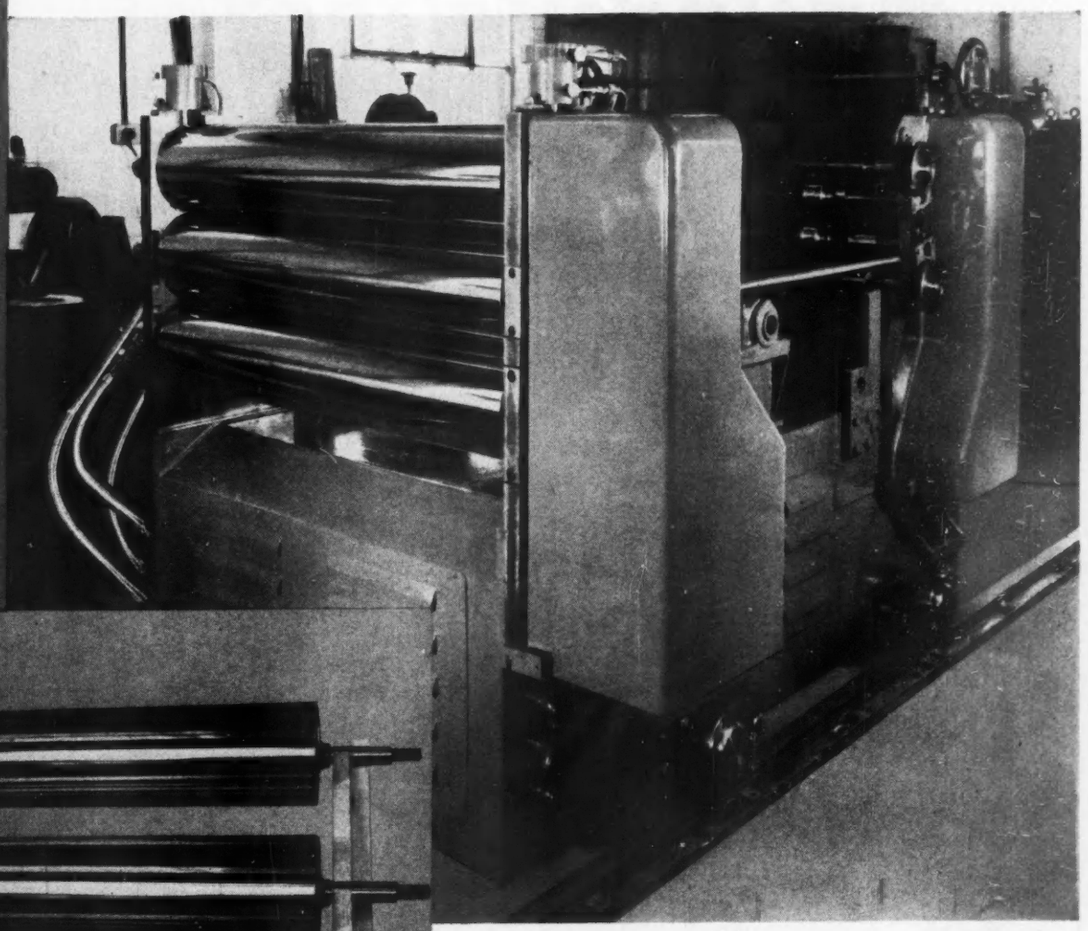

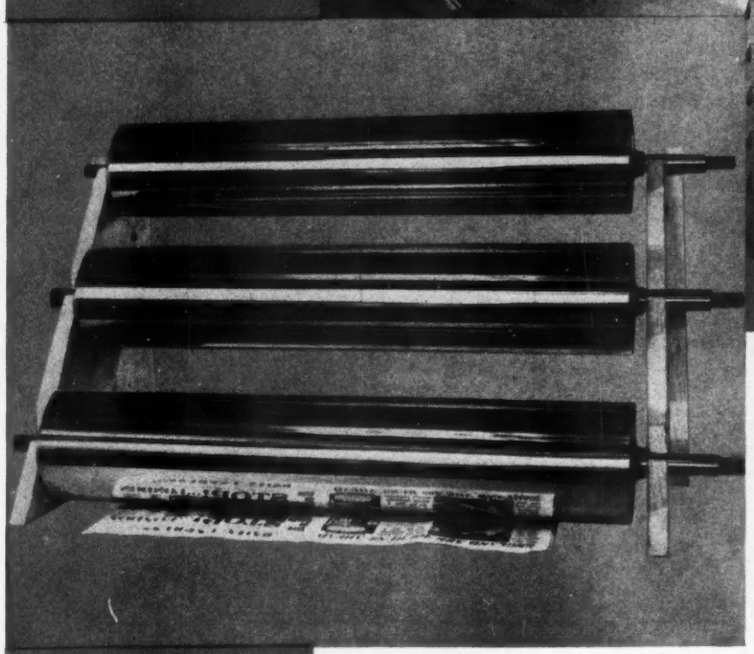

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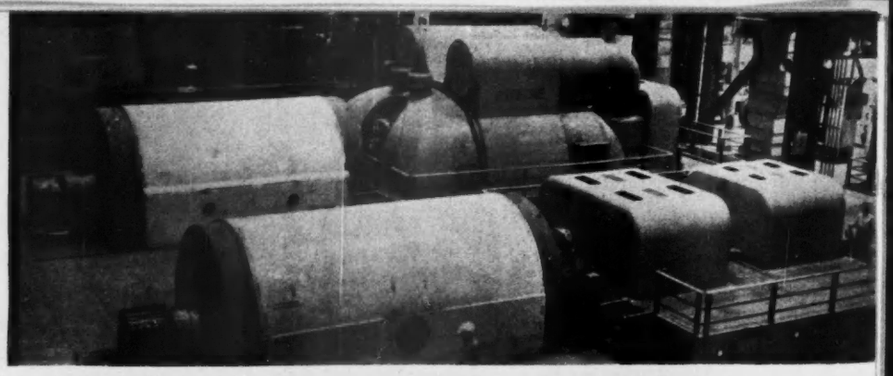
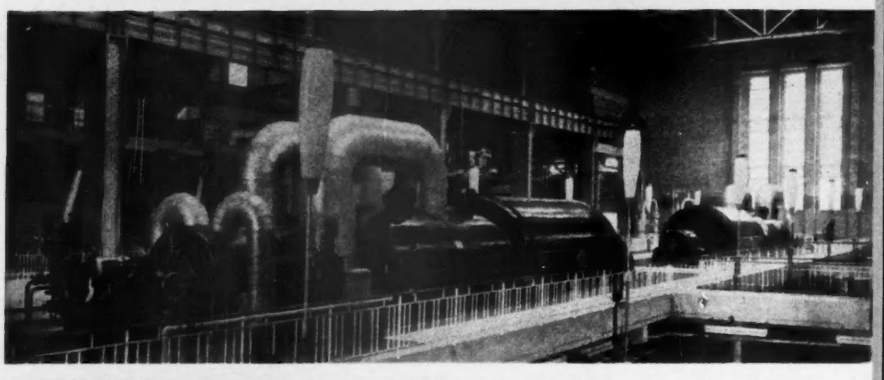
some recent PARSONS turbo-generator installations

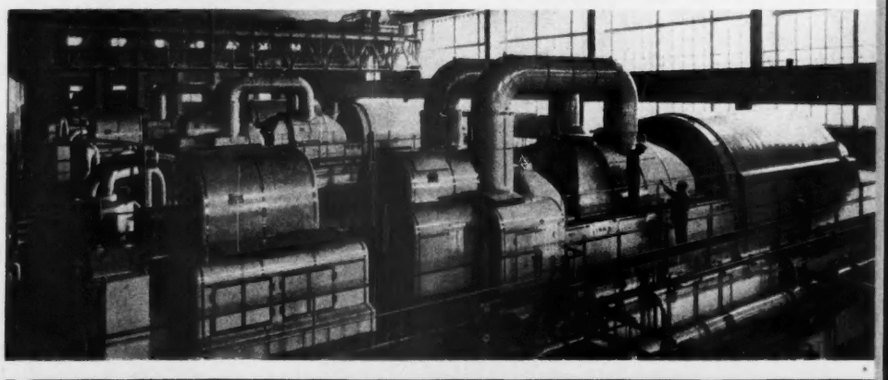


One of four PARSONS 200 MW cross-compound turbo-generators at Richard L. Hearn generating station, Canada

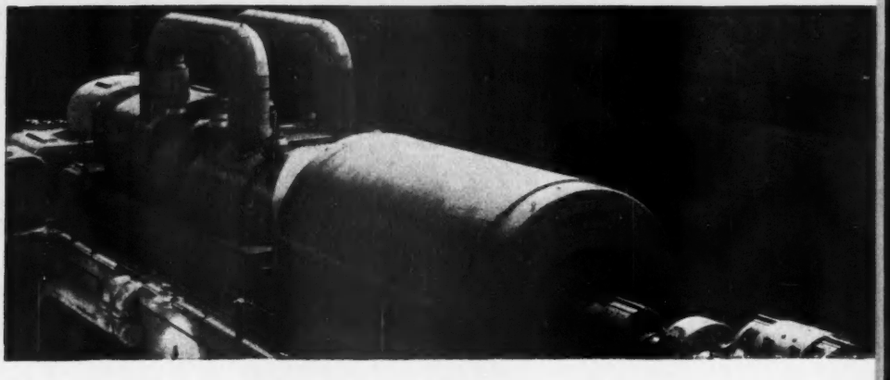
One of three PARSONS 120 MW turbo-generators at Kincardine power station, Scotland



Two PARSONS 60 MW turbo-generators at Little Barford power station, England



Three PARSONS 100 MW turbo-generators at Ferrybridge power station, England



One of four PARSONS 120 MW turbo-generators at Drakelow power station, England

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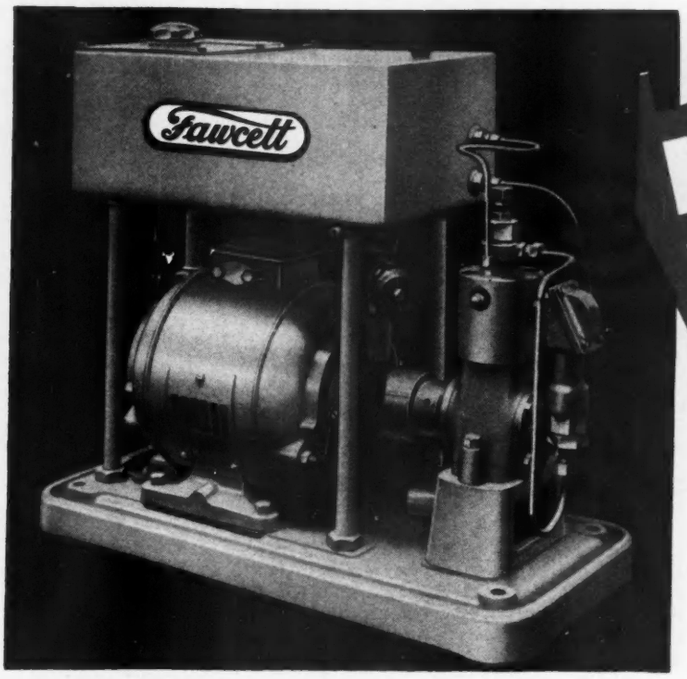

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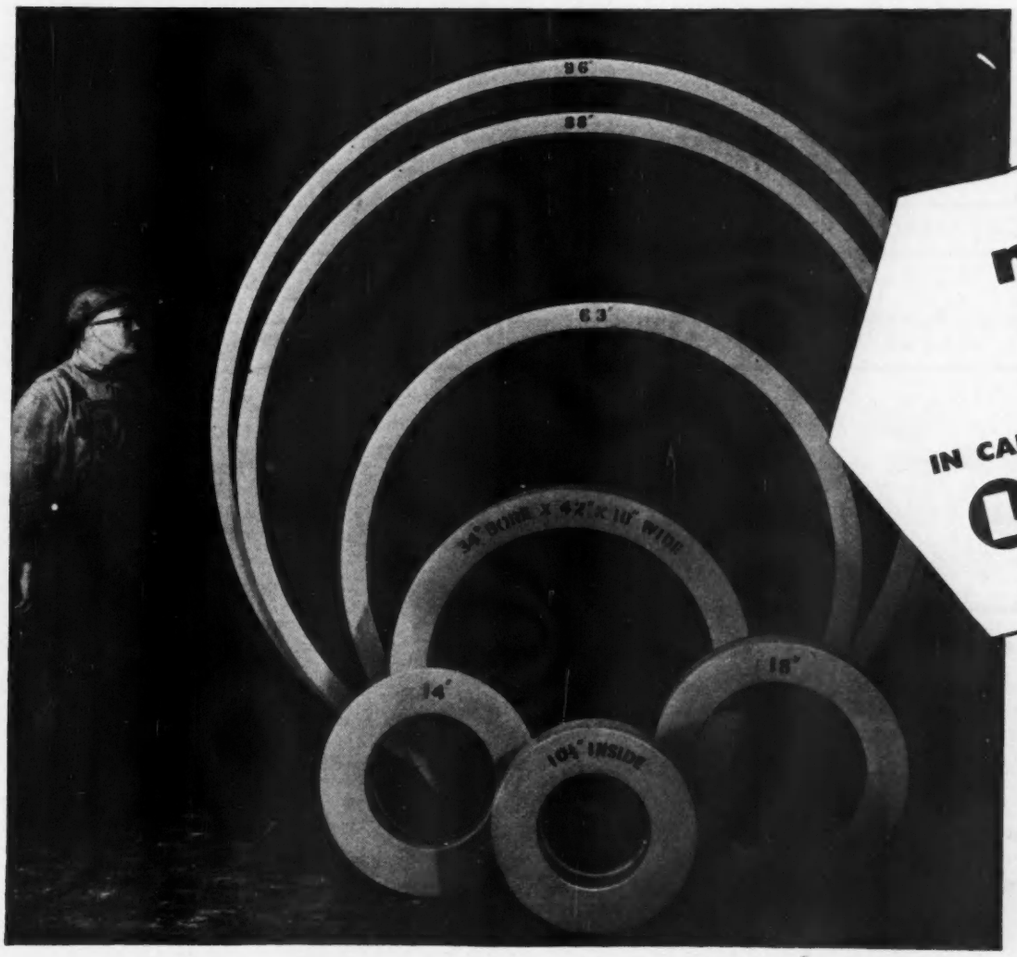

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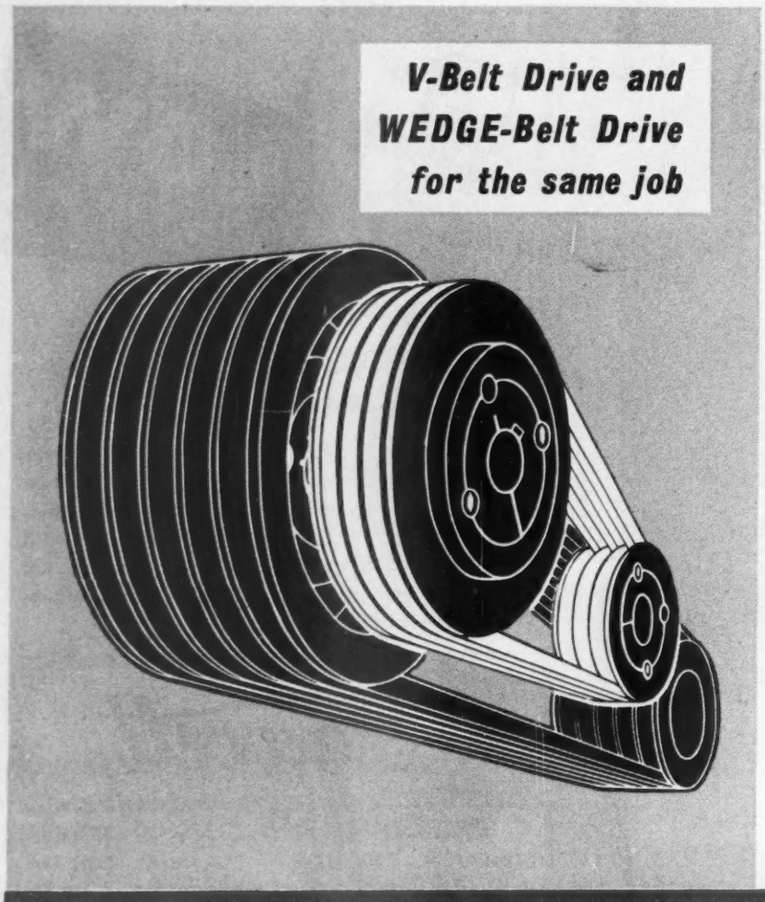

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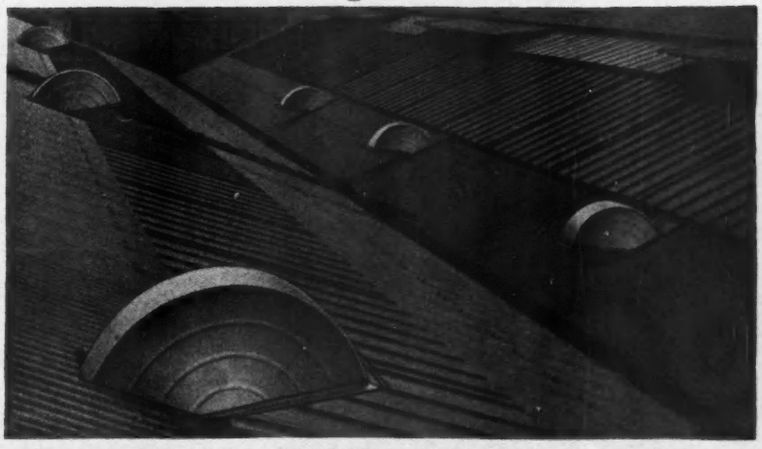

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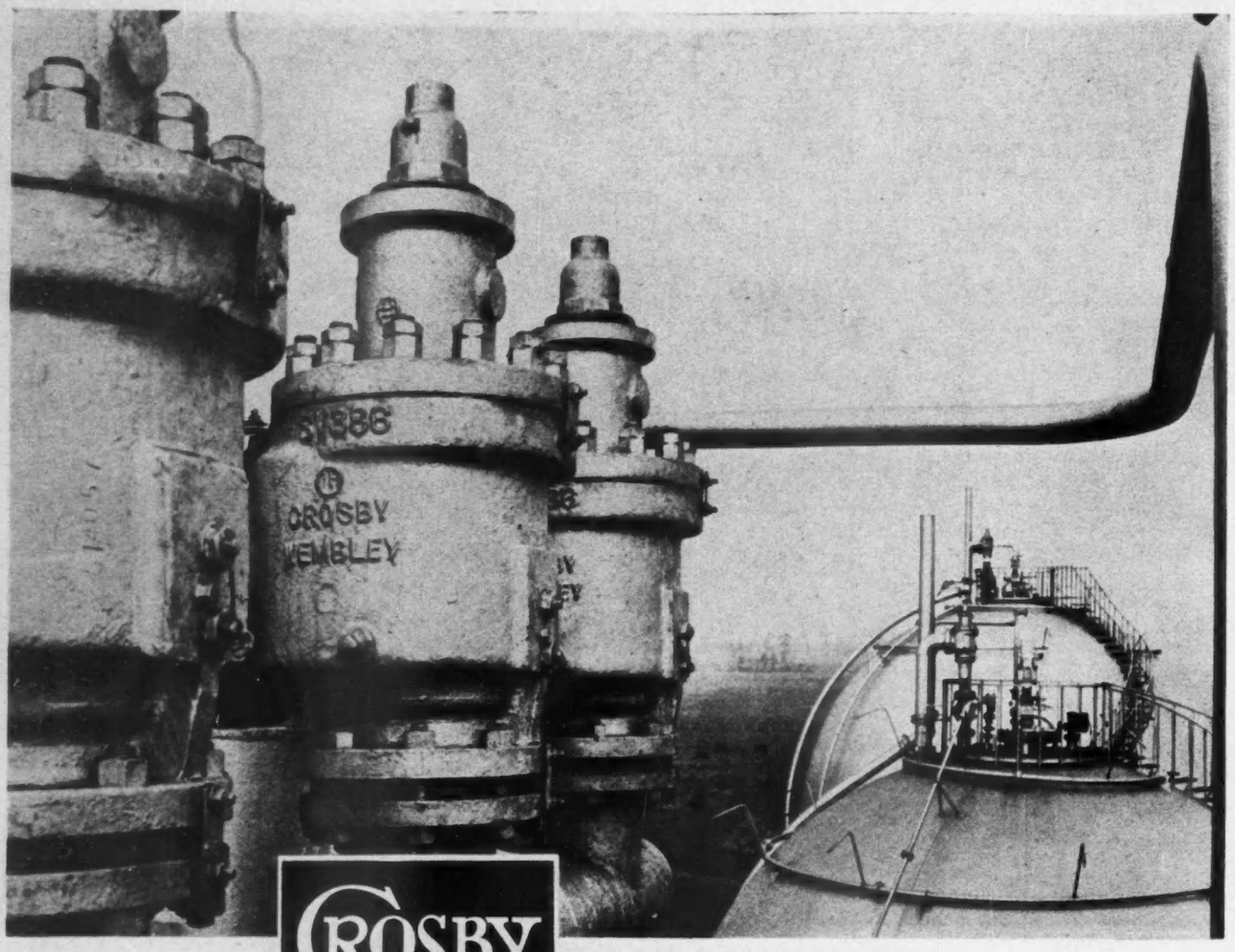

SHELL USE CROSBY MASONEILAN EQUIPMENT AT SHELL HAVEN

Illustration shows three of four 6 x 8 Crosby Relief Valves together with Masoneilan Liquid Level Transmitters mounted on each of three Butane Storage Horton Spheres at Shell Haven. These relief valves protect the tanks from overpressuring. The level instruments transmit the level of liquid Butane in the Spheres back to the Receiver in the control room. The reliability of this equipment is thus exemplified once again by one of the major oil companies of the world.

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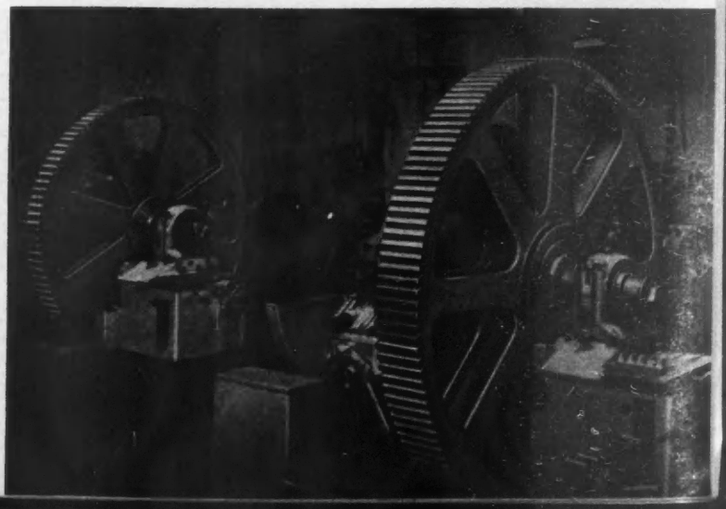

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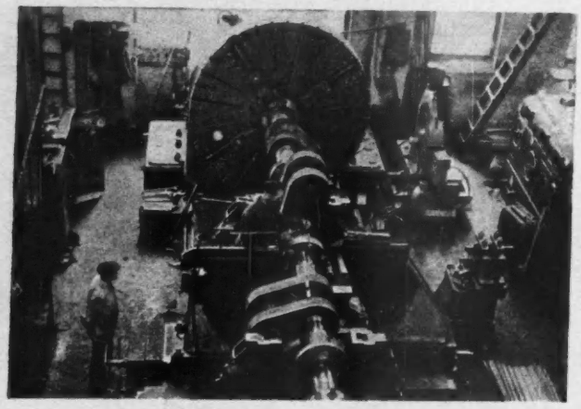

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On the left—below pump house floor level, a four-stage, 1,000,000-gallons per day borehole pump driven by a 90/125-h.p. variable-speed d.c. motor, between two three-stage, 2,000,000-gallons per day horizontal booster pumps, each driven by a 150/200-h.p. variable-speed d.c. motor. Two identical 90/125-h.p. motor-driven borehole pumps are also in service in outlying houses. On the right—two diesel engine generating sets for supplying electricity for the operation of the station's plant and services : these also provide 100 per cent. standby. Each set comprises an 8-cylinder, 576-b.h.p., 450-r.p.m., four-stroke engine directly coupled to a 398-kW, 460-volt generator.

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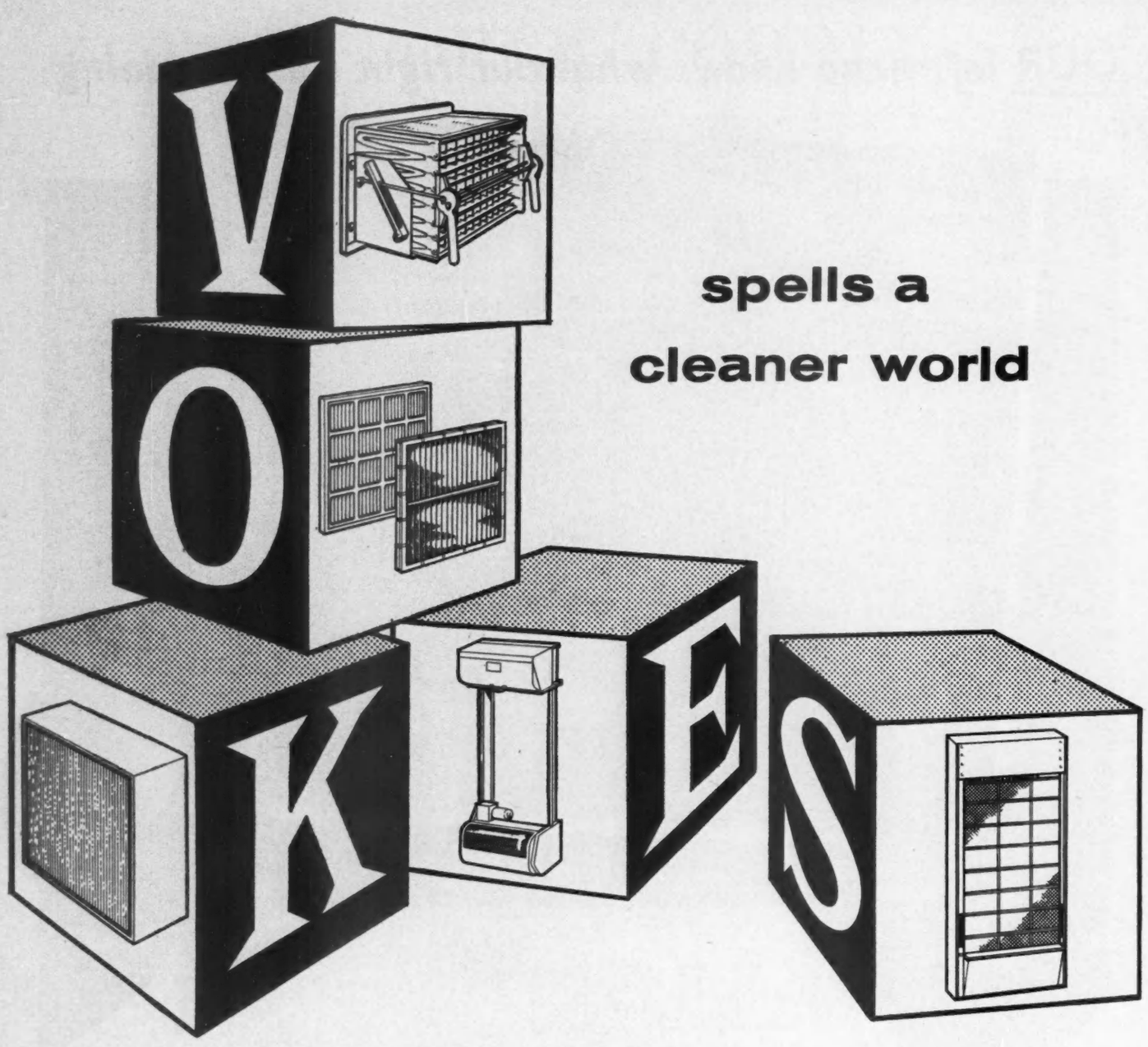

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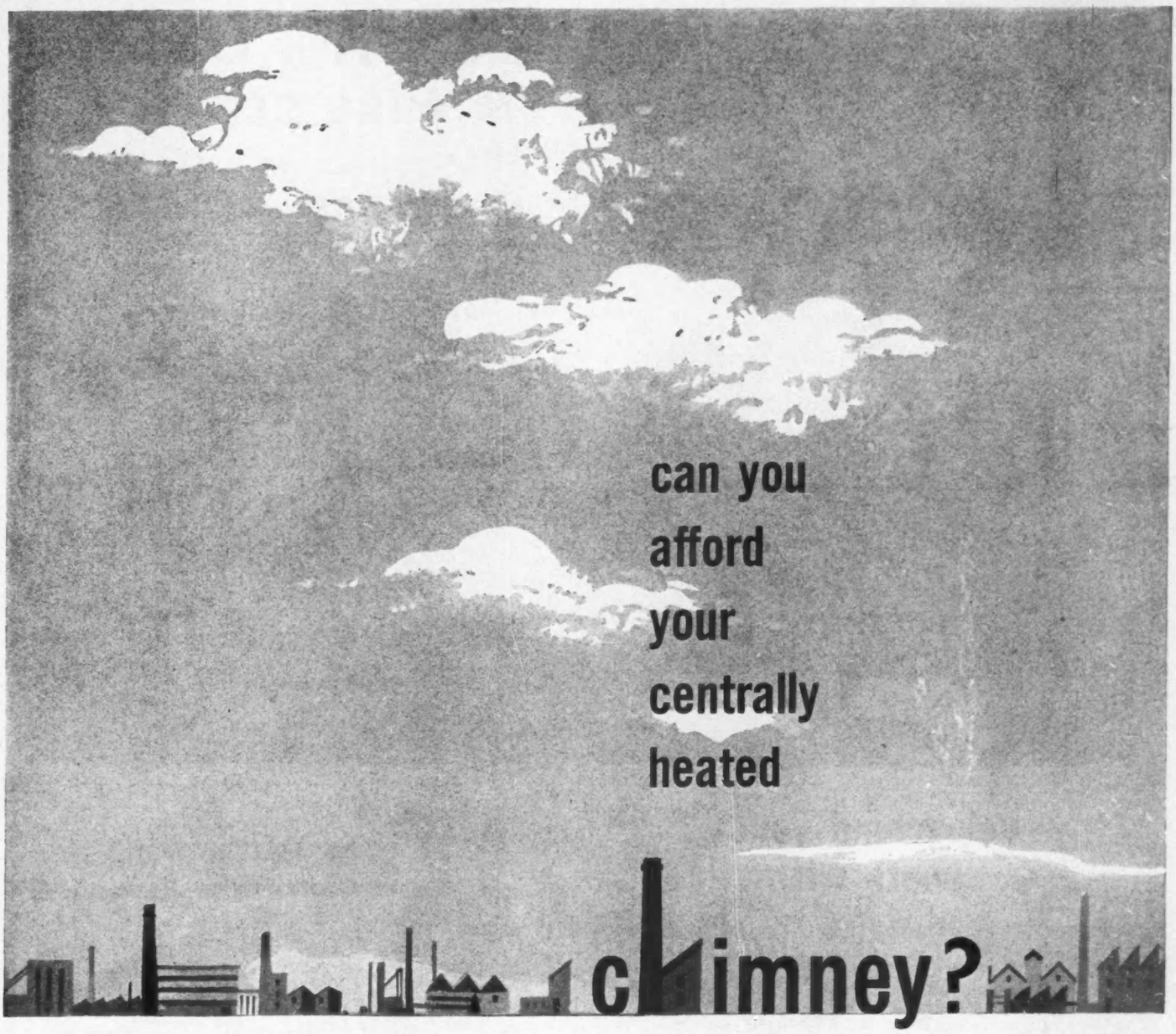

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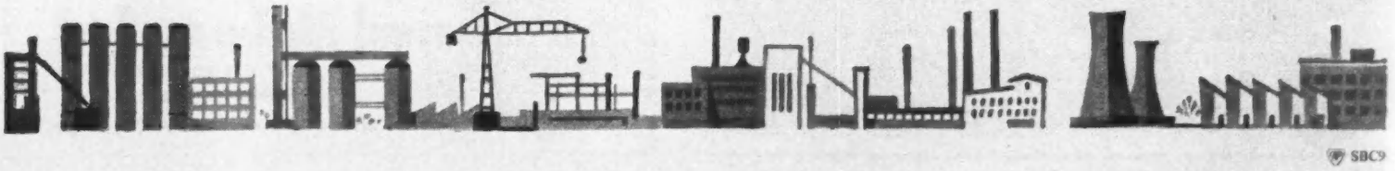

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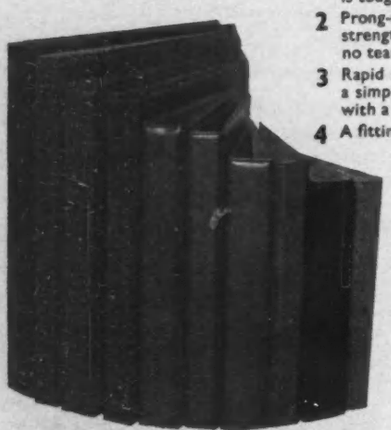

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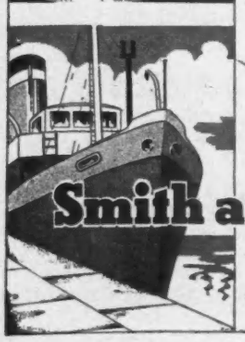

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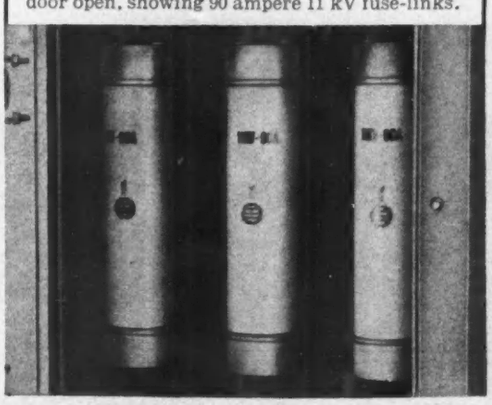

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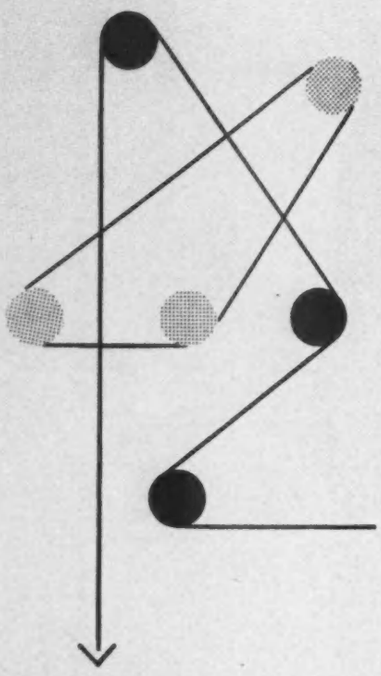

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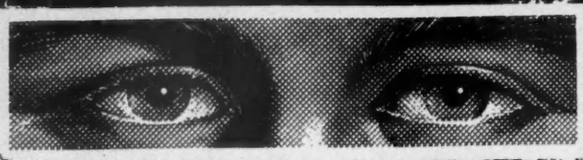

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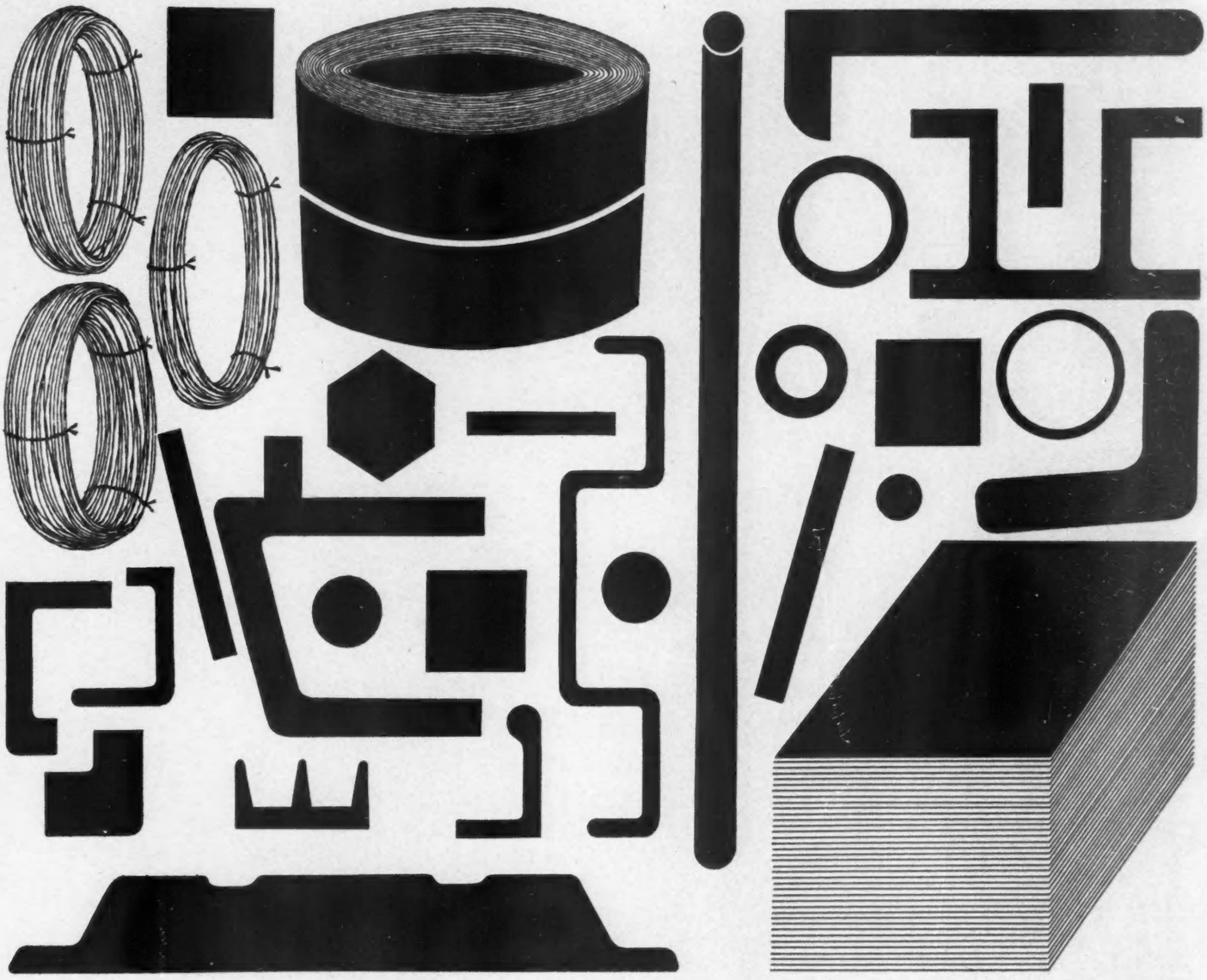

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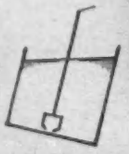

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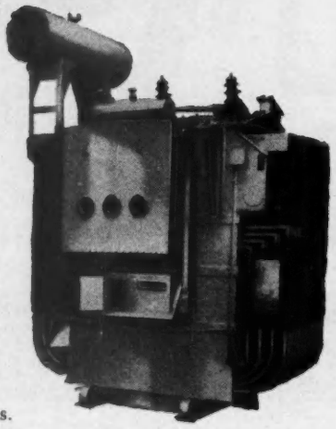

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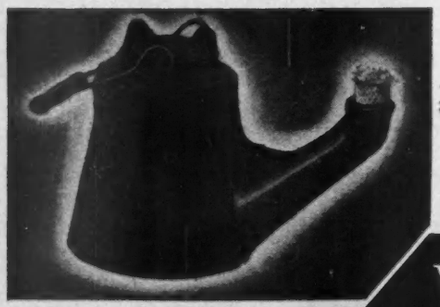

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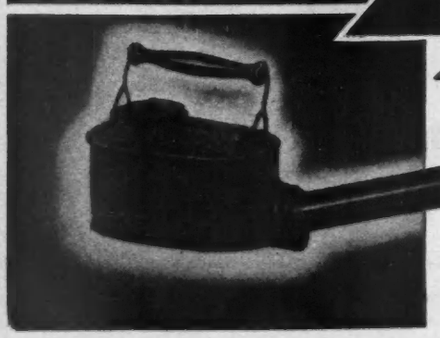

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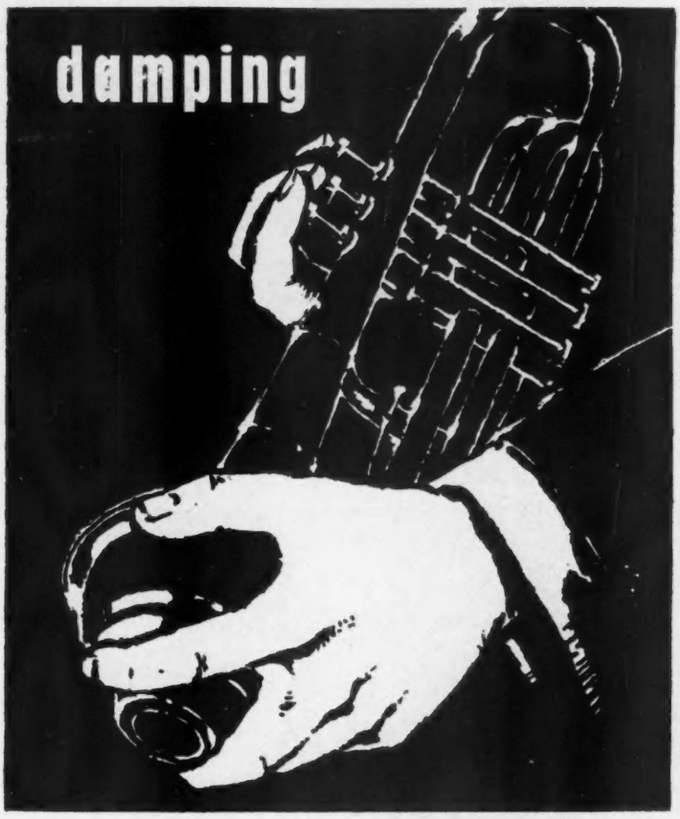

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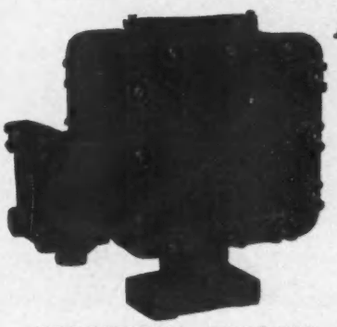

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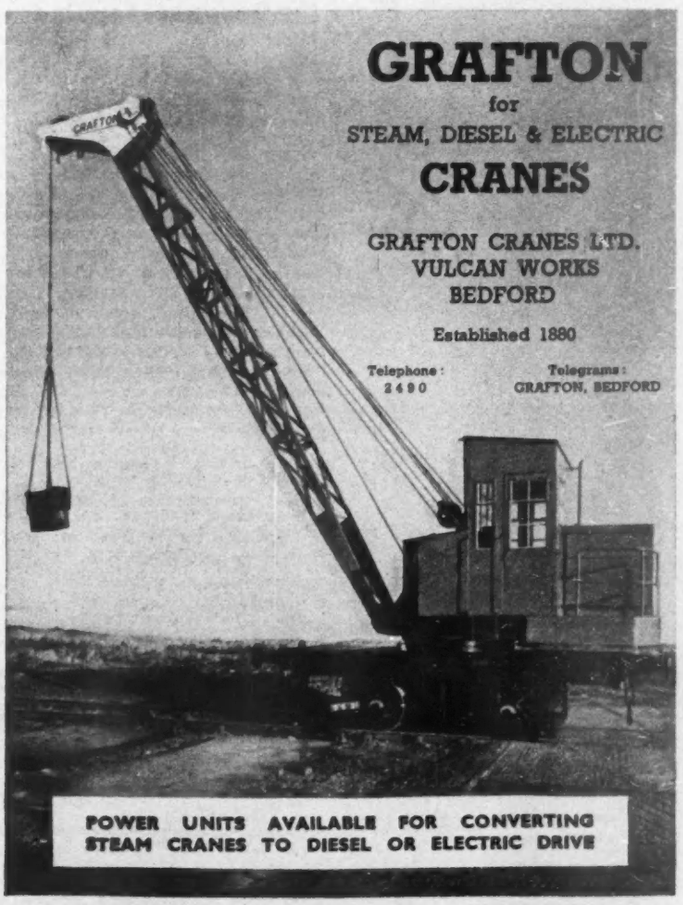

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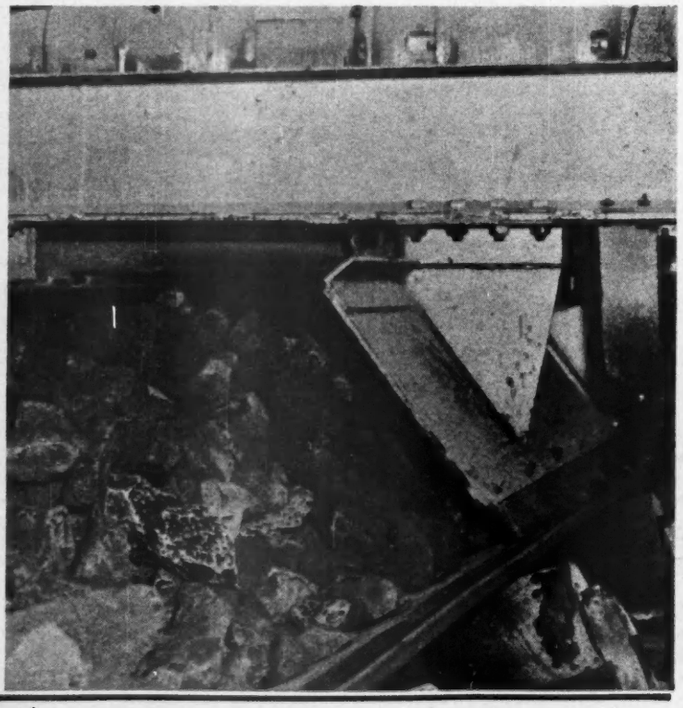

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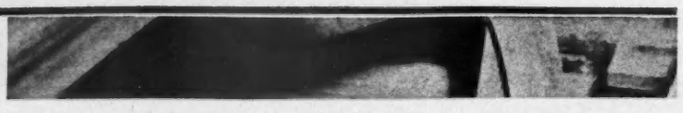


ENGINEERING Impact

of Multi-National Space Cooperation

A COMMONWEALTH-EUROPEAN organisation for launching satellites is now a stronger possibility than at any time since it became known that Britain would not be going all the way on her own.

Mr. Peter Thorneycroft, the Minister of Aviation, has talked with the French Prime Minister, Mr. Debre, and other French leaders, for two days and the results have been sufficient for reports of the discussions to be sent to all the Governments of the Commonwealth and of Western Europe.

The next stage in the process is for the United Kingdom Government to hear from the French the result of their detailed studies of all the complex points that arise. After that it will be possible to go one further in wider talks with other nations.

For industry the effects of agreement on this project would be entirely beneficial. Some of the electronics firms involved in the control mechanisms already have their subsidiaries in the European Common Market territories.

Instruments, Not Men

They might expect to gain contracts not only in the UK but on the Continent as well. An earlier visit by Mr. Thorneycroft to Australia produced the statement that it would be technically feasible for a launching programme to be developed making use of the Woomera rocket range facilities. Commonwealth-European cooperation in this field could thus be good news for Australian industry in a number of directions.

At London Airport last week, as he returned from Paris, Mr. Thorneycroft explained that he was not thinking of a programme which would lead to sending men into space. What is more lilely is the launching of satellites containing substantial quantities of instruments. Communications satellites would obviously be very much a probability, if the lengthy process of sounding opinion from so many governments can be conducted with something like the speed that went, for instance, into the formation of the British led European Free Trade Area.

No Alternative

"Sharing the costs among friends," in Mr. Thorneycroft's words, would not only be a great help all round, it has the compelling advantage that national resources being what they are it may be the only way in which countries other than the United States and Russia can get into space at all.

There could be an important side effect from the day to day workings of a Commonwealth-European space organisation. With many British companies directly participating in the trade of the European Common Market, and with Commonwealth countries joining in the space project, the assembling of a divergent Europe into one cooperating whole would be a significant step closer.

Holding Back Advance on the Railways

The Minister of Transport's policy, if that is not too ambitious a word, for transport in Britain has now come full circle to the point where it appears to be actively destructive instead of merely laggardly and inept.

On every hand, except that of the Ministry itself, can be heard arguments, fully supported by the facts, for building more roads, better roads, for dealing with traffic chaos in the big cities, for removing the enormous brake on our industrial advance that the road system now imposes. There are loud enough fanfares at regular intervals. They do not conceal the failure to get on with the job.

And now the carving out of 1961's spending by the Transport Commission of £25 million, an eighth of its planned expenditure, is justified with a reference to the miserable parsimony of the road programme. Mr. John Hay, the Parliamentary Secretary to the Ministry of Transport, said in the debate in the House of Commons that the British Railways' London Midland electrification scheme would cost £160 million —two and half times the amount spent in a year on major and new road construction. He wondered if such spending on the railways was now desirable.

Levelling Down

Where would Mr. Hay look for his argument if an adequate national road plan, of many times the £160 million during the period of the London Midland electrification scheme, were being carried through? It is bad enough to find a Government Minister with this devotion to levelling, but when it amounts to levelling down to a standard of dreary do-nothingness then the future looks singularly cheerless.

Given just a moment's impartiality, the simple fact would shine through that in the electrification before the war of its suburban services, the old Southern Railway had a plain economic success. Electrification, by giving improved operating figures, better service to the passenger and to the industrial user is where the railways' future as a national asset may be shown to exist.

Disruption

Throughout Europe, and in many other countries, railway investment is channelled into gradual schemes of electrification. This avoids the costly stop-gap methods forced on the British Transport Commission. It is a painful absurdity for the Government to call with one voice for better export efforts from industry and then to disrupt the efforts of the BTC to give industry a first class transport service.

For cuts in one of the essential modernisation schemes (while present contracts are being continued new contracts are not being placed) to be made, and then justified in this "what's bad enough for roads is bad enough for rail" fashion is about as silly a position as can be imagined.

It is almost as if some malignant influence, realising that the state of the roads is getting worse rather than better, had decided that in order to keep face the same had better be brought about on the railways.

of the Competitive Idea From British Shipyards

The Government plans for financial aid towards the cost of building a replacement for the Cunarder Queen Mary assume increasing importance as the outlook for the shipyards becomes progressively more serious.

When the cancellation of orders for 15 ships, totalling 140,000 tons, is taken into account the additions to the order book were short by 700,000 tons of the gross tonnage completed in the first nine months of the year. With a considerable proportion of the total order book, 437 merchant ships of 3,494,000 tons gross, deferred until better times in shipping, the rate at which completions are eating into the work available is a genuine cause for alarm. The Shipbuilding Conference puts it that "the outlook for the industry is not reassuring."

Unemployment, falling value of the shipbuilding companies, a widening circle of unused capacity in the industries who supply the yards, these are the prospects directly ahead unless a relatively swift change occurs.

Unhelpful Development

Plainly an improvement in freight rates, whether in general cargo or tankers, would lift some of the deferments and keep yards and men at work. There has been a faint rise but nothing substantial and it is not immediately possible to determine any very large increase in the volume of raw materials being carried from the primary producing countries to the industrialised nations. World trade in manufactured goods continues to expand. But not at a great rate in its physical volume. Office machinery, or for that matter agricultural tractors and equipment do not add enormously to the cargo space required.

A scrap and build policy would help enormously. Shell have given a lead in the tanker field. But to do any large amount of good, for Germany and Japan are affected similarly if not in the same degree, scrapping would have to be pursued in many countries and many shipping companies and there is not much sign of that.

Leading the Customer

One effect of the modernisation schemes in the yards has been much faster rates of completion. This is not simply a faster way of working the concern out of a job. If the means to go at the increased pace were not there the order would probably be in Germany, Holland or Japan.

The company that goes on making a product too few people want is the classic salesman's example of a company heading into trouble. This is not to suggest that the shipyards should diversify into some other field.

When there are too few orders for the sort of ships a yard can build, it is little comfort that the unwanted ships can be built at record speed. But most of the world's population is still confined within the borders of its home country because travel abroad by present sea or air methods are too expensive for them.

Competitiveness should perhaps then show itself in the production of transports that are so favourable against the existing vessels that the operators must, in order to stay in business, order the product of the shipyard which is in advance of the others.

It is perhaps worth putting it down that in order to sell ships it is becoming necessary to sell ideas.

A Little Pause in the American Economy

When President Eisenhower refers to "a little pause" he is not talking about any temporary hiatus in the overseas influence of the United States while the Presidential election goes through its last stages.

He is in fact speaking of the economy of the country and agreeing with the American Retail Federation who hold the same view. The Federation takes heart from a continuing high level of sales and of personal savings. It concludes from this that the American economy is robust.

For the first nine months of the year the total business income was 6 per cent greater than the equivalent period of the previous year.

There are of course variations. Reduction in inventory demand is having a depressing effect on manufacturers and residential building is below the level of 12 months back. New machine tool orders were lower this September than in either August or September a year ago. By way of contrast the level of September deliveries picked up again from the August drop and was substantially above those of last September.

September's deliveries were worth $54 million (against $46 million). Export deliveries were worth $14 million of this total.

When the period of reductions in company inventories comes to an end and with the rising level of activity by United States industry in the export fields a future upswing in activity—beyond the President's little pause—is certain. It will bring with it renewed export opportunities for British manufactured goods, if not necessarily for the motor car industry then still for a wide range of products, from office machinery to heavy plant.

and Steady Expansion In Engineering

All through the summer months the output of the engineering and electrical goods manufacturers went on steadily increasing. Production in August, according to the latest provisional estimates from the Board of Trade, was 8 per cent higher than twelve months earlier. An increase equal to that made in the three earlier months.

The rate of orders in July and August was higher than in the second quarter of the year, for manufacturers of engineering and electrical goods, locomotives and railway track equipment, railway carriages and wagons, heavy commercial vehicles and wheeled tractors.

Home market deliveries, which suffer a seasonal fall at the time of the year covered by the Board of Trade's statement, fell less in the export markets than at home. The Board's provisional index for export deliveries fell 10 points during August to 95 (1958 = 100). The index for home deliveries declined by 14 points from the July level of 106 and 26 points from the peak reached in June.

Ni-Hard Grinding Balls Far Outlive Steel

Double tempering of Ni-Hard cast iron balls increases their already high abrasion resistance, so that they last more than 14 times longer than steel ones under practical sinter milling conditions.

By R. H. T. Dixon, A.I.M., A.C.T.(Birm.)

Mond Nickel Company

NI-HARD, which is a martensitic, alloyed white cast iron, normally containing about 4 per cent nickel and 2 per cent chromium, has many established fields of application in which its characteristic properties of outstanding wear and abrasion-resistance are utilised to advantage. In the as-cast condition the microstructure of this material is normally of the form shown in Fig. 1, consisting of dendrites of austenite-martensite aggregate in a continuous eutectic-carbide network.

For some applications, involving repeated light impact in addition to abrasion, e.g., balls in a grinding mill, it has been found advantageous to apply heat-treatments designed to temper the as-cast martensite and, at the same time, to transform retained austenite to bainite and/or tempered martensite, giving a structure such as that shown in Fig. 2. It has been demonstrated, in the Mond Nickel Company's Laboratory, that correctly tempered sound Ni-Hard balls have impact-fatigue lives far longer than those which can be expected from similar balls in the as-cast condition. Such improvement has been shown, for example, in 2½ in diameter sand-cast Ni-Hard balls tempered for 4 hours at 450° C followed by 4 hours at 275° C. In a test which consisted of dropping the balls repeatedly on to an anvil from a height of 21 ft all the as-cast balls fractured in fewer than 500 impacts, whereas tthe double-tempered balls were unbroken after 10,000 impacts.

Effect of the tempering treatment on other properties was also examined, and it was found that while it caused some increase in the micro-hardness of the $\alpha + \gamma$ phase (due, no doubt, to the transformation of the soft austenite phase to either bainite or tempered martensite), the average hardness of the iron was lowered by such treatment from about 705 to 680 DPN.

To assess validity of the laboratory findings, double-tempered balls were tested in a ball mill under normal commercial conditions.

Ball Mill Tests in a Refinery

Arrangements were made with Mond Nickel Company's refinery in Clydach, South Wales, who were interested in the development and testing of improved types of Ni-Hard, to test a batch of 200 2½ in diameter sand-cast balls. These balls, compositions of which are given below, were given the double-temper heat-treatment referred to above and were used to replace a similar number of forged medium-carbon steel balls in the second compartment of a Schmidt ball mill of 6 ft internal diameter. Details of mill operation are given in the table: the mill operates under dry conditions, with a normal air-current discharge. Ni-Hard balls were added during the normal weekly ball check and during the following week the mill was opened daily to examine these balls for wear and breakage. It soon became apparent that Ni-Hard balls were easily distinguishable from forged-steel balls, by virtue of their bright surface appearance, compared with dull surface of steel balls. During the first week of service many balls were examined on each occasion, but no breakage was observed, and it was therefore decided to inspect only once a week. At each subsequent inspection some 20 balls were removed from the mill, tested to ensure that they were Ni-Hard, weighed and replaced. In this way it was possible to follow the progress and nature of wear.

Composition of Ni-Hard Grinding Balls in Tests

Content, per cent						
Carbon	Silicon	Manganese	Sulphur	Phosphorus	Nickel	Chromium
3·2	0·3	0·5	0·01	0·03	3·8	1·8

Operating Date During Tests in Schmidt Ball Mill

Charge material	Nickel oxide sinter plus fine metallics size ⅛ in to fines
Balls currently used	steel
Temperature of charge in mill	50–70° C
Balls in first compartment	2,000 lb– 70 mm 5,000 lb–50–60 mm } steel 2,000 lb– 50 mm
Balls in second (test) compartment	2,200 lb– 60 mm 4,000 lb–50–60 mm } steel 2,500 lb–40–50 mm 310 lb–56 mm Ni-Hard
Speed of mill	20–21 r.p.m.
Balls added each week first compartment second (test) compartment	700 lb–70 mm } steel 600 lb–60 mm
Complete ball removal and regrading of steel balls	every 3 months (approx.)
Rate of wear on 9,000 lb—steel balls	1·8 lb per short ton of sinter milled
Calculated rate of wear on 9,000 lb—Ni-Hard balls	0·084–0·127 lb per short ton of sinter milled
Size of Ni-Hard liners with cement-asbestos backings	2 ft 6 in square by 2–3 in thick
Mill division grids	slotted Hadfields Mn-steel (these slots tend to close up during service)
Mill output	Approx. 100 tons per day (5·7–6·0 tons per hour)
nternal diameter of mill	6 ft
Daily operating cycle	18 hours milling, 5–6 hours stationary. (usually shut-down in the early hours of the morning)

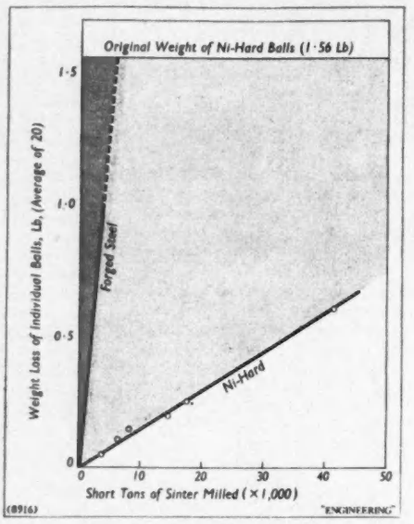


Fig. 3 Forged steel balls wore more than 14 times quicker than double tempered Ni-Hard ones.

Regrading of the balls was done at approximately three-monthly intervals. On these occasions all the Ni-Hard balls were removed from the mill, inspected, and weighed prior to being replaced in service. Rate of wear of Ni-Hard balls under these conditions is illustrated in Fig. 3, in the form of a graph showing rate of wear of a Ni-Hard ball as a function of weight of sinter ground in the mill. It is apparent from this that loss in weight of balls is fairly constant down to two-thirds their initial weight; in other words, this confirms practical experience that the lb per lb wear rate is greater with small balls than with larger ones. When the wear rate of Ni-Hard balls is calculated as if all the 9,000 lb charge were in this material, the total loss would be 0·084 lb per short ton of sinter ground with 56 mm balls, or 0·127 lb per short ton with 50 mm balls (the latter calculated from losses on worn balls). This compares favourably with the figure for forged medium-carbon steel balls normally used, which is 1·80 lb per short ton with a mixed charge of 50 to 70 mm diameters. The wear factor in favour of alloy cast iron is therefore at least 14 : 1, and would approach 20 : 1 if the initial size distribution were retained. Although all the Ni-Hard balls charged in the mill had been examined in detail on four occasions during the test, no evidence

Fig. 1 Ni-Hard in the as-cast condition. Etched 2 per cent Nital. Magnification ×250.

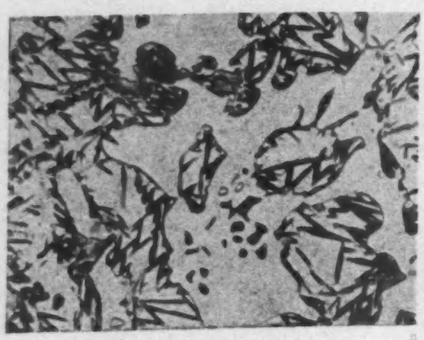


Fig. 2 Ni-Hard after heat treatment at 450 and 275° C. Etched 2 per cent Nital. Magn. ×250.

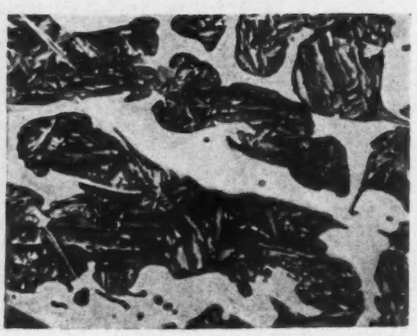
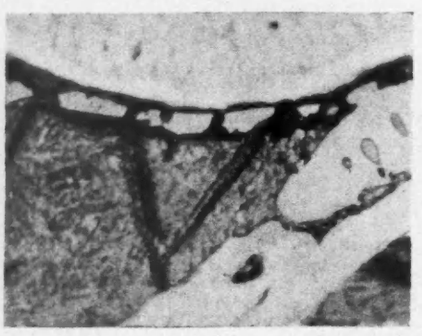


Fig. 4 Surface of Ni-Hard ball after service. Etched in 2 per cent Nital. Magn. ×1,000.



Fireproof Solvent Has Low Toxicity

For between 40 and 60 per cent extra material cost it is now possible to replace trichlorethylene degreasing systems with a chemical which has very low toxicity. This is Chlorothene NU, an inhibited grade of chlorinated solvent made by Dow Chemical Company in the USA and now to be marketed by Penetone-Paripan in the United Kingdom.

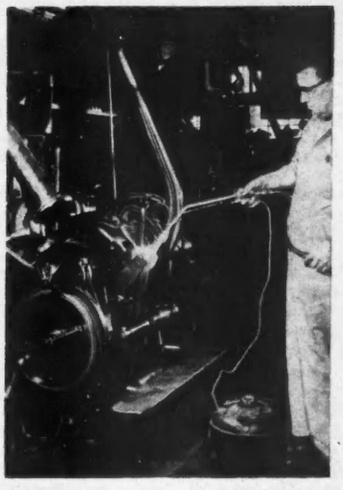
Fireproofness is retained, for like trichlorethylene it has no flash point or fire point. Solvent properties closely parallel those of carbon tetrachloride and it will soon clear greases, oils, tars and waxes. The makers say it is suitable for dip, spray, slush and wipe cleaning and, unlike carbon " tet ", may be used on electrical apparatus such as generators, motors or printed circuits without leaving a film liable to cause tracking.

Inhibitor is incorporated so that corrosion of metals is suppressed. This is nothing new for solvents in the trichlorethylene family, but this favourable characteristic is nevertheless retained in Chlorothene NU.

Most important of the new material's properties is its low toxicity. Thus in the HM Stationery Office booklet *Toxic Substances in Factory Atmospheres* the permissible concentration of this solvent is 500 p.p.m. compared with 25 for benzene and carbon tetrachloride, and 200 for trichlorethylene and perchlorethylene. The evaporation rate at room temperature, which reflects in part the vapour pressure, is identical with carbon tetrachloride and is only 30 per cent greater than for trichlorethylene; so this means that when used in open tanks or for spray or slush cleaning, there is far less danger of exceeding the toxic doses than with other solvents of this type. Combining increased cost with the desirable characteristic of low toxicity, the material will naturally compete only for open uses rather than for vapour degreasing baths. Here, its characteristic of forming sludge from " dissolved " dirt, oils and waxes, will help to keep the bath clean; in this respect it is thought by Peritone-Paripan to be superior to trichlorethylene.

The illustration shows Chlorothene NU being sprayed on to a linotype machine, which is an admirable application. In a similar category can be placed its use by an American airline who find it especially good for confined spaces. In such close quarters as a nose wheel compartment, safety precautions demand that the solvent must be of as low toxicity as possible and Chlorothene NU satisfies this requirement.

It seems that this solvent may be of great use to the metal finishing industries. For mass production lines it is convenient if the degreasing agent is compatible with the paint system for it doesn't then matter if the intermediate drying stage is omitted. Not only does the chemical mix readily with several paint systems, but it looks like being a useful solvent in electrostatic spraying where paint conductivity must be held within close limits.



Dow Chemicals will not reveal how much of this solvent is made or marketed in the USA, but the British company do not expect the price to fall greatly and there are no plans at the moment to make it this side of the Atlantic.

Penetone-Paripan Limited, Egham, Surrey.

Concluding **Grinding Balls**

was found of any breakage or spalling.

Balls which had been used in this test were afterwards subjected to metallurgical examination. Surface microstructure of a typical ball is shown in Fig. 4, which clearly indicates that the very hard carbide phase (1,100 to 1,200 DPN) tends to stand out in relief, and that carbide debris becomes embedded in the surface layers of the primary martensite-bainite dendrites. This latter effect is undoubtedly of importance in reducing wear. Microhardness measurements on the surface of worn balls gave values as high as 1,500 DPN. These effects account for the outstandingly good wear-resistance of Ni-Hard components under abrasive conditions and would also explain the bright appearance of the balls observed during the test.

Economics

It is obvious that in the plant at which this test was carried out, saving in operating cost and lessened contamination of the ground product would be obtained by a complete changeover to Ni-Hard grinding media. (The liner plates used in this mill are already in Ni-Hard.) Initial cost per ton of forged steel balls is about £60, compared with £120 for the same weight of Ni-Hard balls, but taking into account the wear factor, the ball-cost per ton of ore ground would be only about 1·65*d* for Ni-Hard as compared with 11·5*d* for steel.

It should be noted that in the tests reported the Ni-Hard balls were used in contact with a much larger number of steel balls and that possibly more wear would occur with an all-Ni-Hard charge, such as is now being installed in the Clydach plant. Considerable saving in the cost of grinding media can, however, still reasonably be expected.

The author acknowledges his indebtedness to the Mond Nickel Company Limited for permission to publish this article.

Oil Injected into Blast Furnace

Esso Research and Engineering revealed recently in America that for more than two years it has been conducting a programme which promises an important development in iron manufacture.

This company, which is the scientific affiliate of Standard Oil Company of New Jersey, said the project is aimed at proving the feasibility of a 75 year old iron-making idea. The concept is that hydrocarbons, particularly heavy oil of high heat content, can be successfully injected into the bottom of blast furnaces and, in many circumstances, can increase capacity and decrease costs of hot metal production.

With the new fuelling system, oil can be injected along with the heated air. Petroleum fuel serves as part of the source of heat and of the reducing gases. One of the Esso Research developments for this application is the fuel injection and control system. Since blast furnaces operate continuously for as long as eight years, this is best designed so that it can be installed into large furnaces without any interruption in use of the furnace.

The company noted that some United States and European steel firms had been working along similar lines with natural gas injection, and that there are reports that some Russian blast furnaces are using natural gas to increase their iron-making capacity.

Esso Petroleum Company Limited, Queen Anne's Gate, London, SW1.

Galvanised Steel in Longer Sheets

John Summers have now incorporated special new machinery enabling them to supply extra long sheets of Galvatite—corrugated galvanised steel sheet. This material is widely used for cladding agricultural and industrial buildings, and introduction of these long sheets will effect economies in building. Sheets which were formerly supplied in lengths of 10 and 12 ft can now be supplied up to 22 ft in length. These long sheets are available in standard 3 in corrugations.

Loss of material at end laps of sheeting both on roofing and siding will be much reduced, as the long sheets span several purlin spacings. In some instances one sheet may span from eaves to ridge or from ground level to eaves. The new method of corrugating ensures that the corrugations are perfectly parallel, making erection easier and reducing building time.

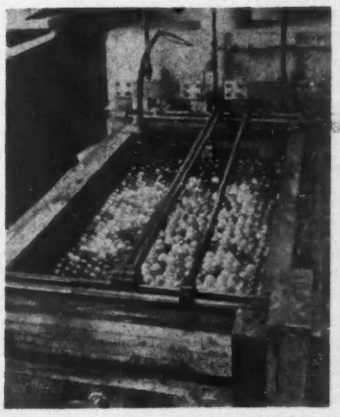
Length of 22 ft is an arbitrary figure and is imposed as a maximum length that can be conveniently handled. Longer sheets can be supplied if customers provide suitable transport.

John Summers and Sons, Shotton, Chester.

Plastic Balls for Plating Baths

Canning and Company are now marketing ball chroffles made from Rigidex high density polyethylene, blow moulded by Lacrinoid Products. These rigid balls have diameters of about 1¾ in, and are supplied for use in plating and pickling tanks, where they float on the surface of the liquid and form an inert blanket. This cover minimises spray and splashing of dangerous solutions, which reduces busbar corrosion and provides a safeguard for plating shop staff.

The chroffles also reduce heat losses from the surface of the bath and can save as much as 12 per cent of the heating normally required.



Fan exhaust can be reduced and in some cases dispensed with, and this results in appreciable savings in space heating. A further advantage is that use of balls reduces the cleaning and maintenance of exhaust systems, busbars and jigs, with a consequent saving in time and labour.

Due to their shape, ball chroffles take up uneven contours or projections on articles being processed and thus maintain uniform coverage of the solution. High density polyethylene from which they are made will withstand 95° C and is resistant to most acids and alkalies. It is also resistant to oils and the balls are being evaluated as a seal for oil storage tanks to reduce losses from evaporation.

British Resin Products Limited, Devonshire House, Piccadilly, London, W1.

Plain Words

By Capricorn

WAY down in the Tropic of Capricorn, the days are getting longer, but up here in London, New York and Moscow, the nights are drawing in. Do you find, as I do, that the daily cycle of working time is too short for the kind of life we lead today?

To appreciate just how we are being squeezed, remember that until comparatively recently in the life of man, the vast majority of men have carried out their daily working in one place—on the farm or in a room or simple workshop—with only an occasional need to travel to other men or communicate with them.

What is happening today? In the United States, I hear, only a quarter of the working population is now engaged in manufacturing industry. And even among that quarter, only some of the employees are tied to one place of work, at a machine or desk. A very large number of the industrious Americans are engaged in work which necessitates their moving around. Managers and executives of all kinds, commercial travellers, university professors, publicity and advertising men, entertainers, politicians, doctors, lawyers (I am ignoring order of precedence)—all these and many others move around frequently and extensively. They sit on committees, visit exhibitions, attend conferences, call on customers and clients, bask in the hospitality of suppliers, badger government departments, embark on whistle-stop tours.

It is the same in Britain. In this tight little island, we are all for ever on the move. As a result, when we have knocked off the time for the essential activities like eating, sleeping and commuting, it is often extremely difficult to fit in both the work itself and the travel associated with it.

The growth in the division of labour was recognised early by Adam Smith (at least that is the cliché of history which I have always accepted without question) but no one seems to have recognised the monstrous situation which we are creating by the growth in the division of thinking. Fifty years ago, one man sat at a drawing board for days on end and worked out the design of a locomotive firebox. Once or twice the chief mechanical engineer would come down from London to pronounce his blessing on the work, but otherwise there was no to and froing. In these hectic times, the gas-turbine combustion chamber is designed only after the highly complex movements of scores of men from various parts of the country—not just the designers, but also professors, people from research establishments, representatives from computer firms—no one knows how many.

Is anyone looking for some really useful research to carry out? Let him do a case study of the movement and communication of men involved in the inception, design and development of some new product. And let his report be a warning of the communication mess in which we are landing ourselves.

Letters to the Editor

Conserving Natural Resources

SIR, Your note in Impact on the problem of waste (ENGNG., 21 Oct. '60, p. 533) and the excellent articles in that issue recalled the series of lectures at the Institution of Civil Engineers four years ago on the same subject.

They were published by the Institution with my own Graham Clark Lecture on "The Contribution of the Engineer to the Conservation of Natural Resources" in a little booklet, which, perhaps because it was a free issue, failed to secure the publicity it deserved. It is a sound maxim that people only appreciate what they must pay for. I remember particularly well the final and most valuable lecture, by Mr. R. M. Finch, the city engineer and surveyor of Nottingham, in which he showed, like Mr. A. E. Higginson, superintendent of public cleansing, Chesterfield, in your last number, the material and financial benefit that can accrue to a municipality by the scientific disposal of its waste.

Undoubtedly much progress has been made, as indeed, your articles illustrate. In spite of bad spots like Pucklechurch, there is a far better appreciation of the importance of the problem of waste and of its wider implications which I touched on in my foreword. You ask whether its urgency would not justify the appointment of a Royal Commission? I am frankly a little cynical about the cumbrous and slow moving machinery of such a body and I wonder whether the Department of Scientific and Industrial Research, which is already taking an active interest, could not conduct an inquiry into the practical issues that your timely articles raise, with the cooperation of the bodies directly concerned, such as the engineering institutions and the Federation of British Industries.

The secretary of the Institution of Civil Engineers tells me that copies of their booklet on *The Conservation of Natural Resources* are still available to those interested who ask for it.

Yours faithfully,

HAROLD HARTLEY.

London, W2.
27 October, 1960.

Mixing Gases

SIR, May I thank the authors of comments on my article on "Mixing Gases and Gibbs' Paradox" (ENGNG., 16 Sept. '60, p. 398)? The variety of expressed opinions only shows that the problem raised in my paper was not so simple as it seemed to be and therefore deserved indeed a new investigation. I reply here to the different comments in chronological order.

When I took the liberty to address the British engineer, it was not in order "to discourage him from using the concept of permeable membranes," as it is assumed in the letter of Mr. E. A. Bruges (30 Sept. '60, p. 436), but only to remind him that such membranes are almost always merely fictitious. Of course, this fact is well known; nevertheless, the authors treating the problem of the mixing of gases (and among them Mr. Bruges himself, in Chapter 5 of his *Available Energy and Second Law Analysis*) find it easy to bring about a reversible mixing of two gases by means of permeable membranes or pistons and thus arrive at Gibbs' paradox and to a calculated (but only imaginary) decrease of available energy.

Now, the advantage of the throttling process, which I assumed in my paper, is its simplicity: it leads to the same entropy change as the assumption of permeable pistons, but without having recourse to this artificial conception. It is obvious that I might have calculated the entropy change by using (as Mr. Bruges does in his book) the fiction of permeable pistons, but that would not have changed my conclusions. Finally, in the section of my paper which is entitled "Interpretation," the perfect gas is to be considered at rest.

After this clarification, I hope that Mr. Bruges will continue the examination of my article; and if my proposed solution of Gibbs' paradox is a wrong one, I am sure he will not fail to "discourage" me from persevering in my error.

I was glad to learn that, in his letter commenting upon my article, Mr. Boris N. Cole (7 Oct. '60, p. 468) supports my conclusion about the alleged decrease of available energy due to mixing. But I don't see how this statement could be compatible with an increase in entropy which, in Mr. Cole's opinion, "is widely held and not easily refuted." As the decrease of available energy is, for a given temperature of the surroundings, proportional to the increase of entropy, it seems obvious that the non-existence of the first leads to the non-existence of the second. Anyhow, as the entropy change can be used neither for the study of the available energy of the mixture nor for that of its decomposition, it is difficult to appreciate what use could be made of it at all.

As I tried to show it in my article, equation (2) is not only meaningless in the case of a one-gas system, but does not square with the facts even in that of a mixture of two different (but perfect) gases. If it is so, the discontinuity involved in Gibbs' paradox does not correspond to any physical reality.

Mr. Cole finds it questionable to introduce the throttling process in the analysis. I believe that its introduction is justified, as the flow involved in throttling is similar to the flow which occurs during the diffusion. But, in my opinion, this point is not essential; any way of calculation leads to the same value of entropy change, and the very point in question is whether this change of entropy is a real, or only a fictitious, one.

In Mr. N. K. Bowers's letter (14 Oct.'60, p. 501) I appreciate very much his complete agreement with the final paragraph (which is the general conclusion) of my article.

Mr. Bowers is quite right in saying that classical thermodynamics deals only with the macroscopic aspect of the problem. But I think that this aspect is quite sufficient for the calculation of the available energy of a perfect gas. Available energy interests much more the engineer than the physicist; and for the engineer, the entropy change (which is proportional to the change of available energy) is zero, not only when the mixing gases (at constant pressure and temperature) are identical, but even when they are not. It would not be so in the case of dissimilar gases separated by semipermeable membranes, but this case is a very exceptional one.

On the other hand, the microscopic aspect of the problem intervenes when we consider, instead of the available energy of the mixture, the problem of the separation of its constituents. This problem can be solved only by the physicist, not by the engineer or by the (classical) thermodynamicist; and it is precisely a physical theory—the modern theory of information—that is involved in the penultimate paragraph of my article which Mr. Bowers finds questionable. The fact is that when we consider mixtures of gases which are more and more similar, their decomposition becomes more and more difficult; the modern explanation for this difficulty is that the discrimination between the molecules of different kinds needs more and more "information" about their nature, and this information involves an increase of entropy of the system. If the constituents of the mixture tend to become identical, the discrimination between them tends to become impossible; even a Maxwell's demon would be unable to decompose such a mixture, for he could not "see" the molecules without an infinite source of radiation. The infinite value of the entropy of the system only expresses the need of an infinite amount of information in order to make possible the selection of the molecules. This conclusion seems to be valid not only when each molecule is considered individually, but even when it is taken as a member of a group.

Finally, Mr. István Erdélyi (28 Oct.'60, p. 569) reproduces some interesting thoughts about this question which he published in a Hungarian journal almost at the same time as I published mine in a French one. He, too, comes to the conclusion that Gibbs' paradox is not justified, as the entropy of each constituent of a mixture of gases is *not* that corresponding to its partial pressure. Mr. Erdélyi adds that "the concept of partial pressure ought to be regarded as an auxiliary notion for the facility of calculation upon which one cannot always base further arguments." I think it is necessary to make it clear that there is at least one case where such an argument is possible: it is the case of a mixture of which one or many constituents are vapours. In this case, the value of the partial pressure may be very useful, as it enables us to know whether, under the given temperature of the mixture, the vapour is in a saturated or superheated state. Nevertheless, it is quite right that the partial pressures have not to intervene in the calculation of the entropy or of the available energy of a mixture, and this statement was, of course, the main conclusion of my article.

Yours faithfully,
P. CHAMBADAL.

Electricité de France,
Paris.
28 October, 1960.

The Spare Wheel

SIR, In your recent issue Mr. Gordon Wilkins says "the only other car [besides the Chevrolet Corvair] to carry its spare wheel in the engine compartment at present is the little Goggomobil T700 . . ." (ENGNG., 14 Oct.'60, p. 526).

Citroën DS19 and ID19 cars have for several years carried their spare wheels in the engine compartment, in front of the radiator.

Yours faithfully,
BRUCE M. ADKINS.

Seine, France.
27 October, 1960.

Difficulties of Translation

SIR, I wish to thank Mr. W. D. Arnot for his most enlightening article on the need for a careful translation of technical titles (ENGNG., 30 Sept. '60 p. 462), and feel that many authors and translators of techical papers would do well to follow his advice.

First of all, the article points out that "boldly" preserving the original sense is more important than "timidly" using a near-equivalent. Secondly, it is claimed that only translators with the necessary knowledge of the subject in question should be employed.

Apart from advice to translators, however, Mr. Arnot was more or less addressing foreign and, in particular, German authors of technical papers. It was surely not by mere coincidence that all his examples of incorrect translations were taken from German technical journals. It is my opinion that the real cause for Mr. Arnot's complaint is not so much a question of careless translation as of the original composition of titles or headings.

Without going into detail, there are three reasons which combine in making many headings in German technical papers difficult to understand, even for translators and readers who can claim German as their mother tongue. There is that fruitlessly criticised tendency to confound the heading with a summary of the content, thereby cramming too much into the resulting three-line title. At the other extreme, it is a mistake to give an article a heading so short as to read like the name of a ship, just as a means of registering it. The obvious way, therefore, is to keep to the middle course.

Another tendency, typical of German headings in all kinds of scientific papers, is to avoid absolutely the use of verbs and to refer those endless composite nouns. Finally, there remains the fact, frequently quoted, also in ENGINEERING, that the best engineers writing their own articles do not necessarily have a writer's command of their own language.

In view of these difficulties, it would be good practice to have all important translations that may be published thoroughly checked and corrected by more than one translator. Besides which, it has been my experience that, in many instances, the difficulties arising from translations may eventually lead to the improvement of a weak original.

To sum up, both author and translator can learn something from Mr. Arnot's article and the essential point would seem to be the close cooperation between translator and engineer.

Yours faithfully,
FRITZ RUEF.

Augsburg. Germany.
21 October, 1960.

Events in Advance

Waste Heat Recovery From Industrial Furnaces

BOURNEMOUTH has been selected as the venue for the second conference to be arranged by the Institute of Fuel on waste heat recovery from industrial furnaces.

It will be held during the five-day period from 15 to 19 May, 1961, and some 20 papers will be presented, dealing, among other aspects, with fundamental principles, regenerators and recuperators, the raising of steam from waste heat, heat recovery in the steel industry, heat recovery in industries other than the steel industry, gas turbines as a means of recovering waste heat, and other possible future means of recovering waste heat.

The first conference took the form of a special study and was conducted by the Institute during its 1945-46 session. One of the outcomes of that event was the compilation and publication of the book *Waste Heat Recovery from Industrial Furnaces*, which has come to be recognised in many parts of the world as a standard work of reference on this subject.

During the 14 years which have passed since that work was completed, a number of new methods of recovering waste heat have come into industrial use and important advances in the manufacturing processes employed in certain industries, notably in the steel industry, have necessitated the consideration of new approaches in the application of traditional methods of recovering waste heat.

It will be the purpose of the coming conference to investigate these matters and it is the intention that the papers presented shall be integrated into a book, for publication after revision in the light of the discussion which they evoke. To coincide with the conference, an exhibition of plant and equipment illustrating the recovering of waste heat is being arranged.

Further information respecting both the conference and the exhibition may be obtained from the secretary, the Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1 (Telephone: LANgham 7124). The conference will take the form of a summer meeting and ladies will be able to attend.

Metallic Corrosion First International Congress

The First International Congress on Metallic Corrosion to be held under the auspices of the International Union of Pure and Applied Chemistry is due to be held at the Imperial College of Science and Technology, London, SW7, from 10 to 15 April, 1961.

It is the intention of the promoters that as much as possible of the time available at the congress shall be devoted to the discussion of papers dealing with original work, but first-class up-to-date review papers have also been welcomed. Preprints of papers accepted are due to be issued well in advance of the congress, and all papers, together with the discussions on them, will subsequently be published in book form.

Correspondence relating to papers should be addressed to the honorary secretary of the scientific committee, Mr. H. S. Campbell, British Non-Ferrous Metals Research Association, Euston Street, London, NW1. All other matters should be referred to the honorary secretary of the congress at 14 Belgrave Square, London, SW1. Telephone: BELgravia 3681.

Exhibitions and Conferences

"Evening News" Do-It-Yourself and Hobbies Exhibition.—Tues., 8 Nov., to Sat., 19 Nov., at the City Hall, Manchester. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester 3. Tel. Deansgate 6363.

Work Study Training, Annual Conference on.—Fri., 11 Nov., to Sun., 13 Nov., at Buxton. Organised by the Institute of Work Study, 3 Cork Street, London, W1. Tel. REGent 5301.

Cycle and Motor Cycle Show, 33rd.—Sat., 12 Nov., to Sat., 19 Nov., at Earl's Court, London, SW5. Organised by British Cycle and Motor Cycle Industries Ltd., Eaton Road, Coventry. Tel. COVentry 62511.

Hotel Exposition, 45th National.—Mon., 14 Nov., to Fri., 18 Nov., at the Coliseum, New York. Apply to W. K. Seeley, general manager, National Hotel Exposition, 141 West 51st Street, New York City 19, USA.

Public Works and Municipal Services Congress and Exhibition.—Mon., 14 Nov., to Sat., 19 Nov., at Olympia, London, W14. Organised by the Municipal Agency Ltd., 70 Victoria Street, London, SW1. Tel. VICtoria 9132.

Nickel-Chrome Plating, One-Day Symposium on.—Wed., 16 Nov., at the Royal Festival Hall, South Bank, London, SE1. Organised by the London Branch of the Institute of Metal Finishing. Apply to Mr. S. W. Baier, 9E Cleveland Road, London, W13.

Space Navigation, One-Day Symposium.—Fri., 18 Nov., at the Royal Geographical Society, 1 Kensington Gore, London, SW7. Organised jointly by the Institute of Navigation, 1 Kensington Gore, London, SW7 (Tel. KENsington 5021); and the British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Tel. TATe Gallery 9371.

Industrial Photographic and Television Exhibition and Conference, Second.—Mon., 21 Nov., to Fri., 25 Nov., at the Royal Albert Hall, Kensington Gore, London, SW7. Open to trade and public. Organised by the Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Power and Mechanical Engineering, 24th National Exposition (National Power Show).—Mon., 28 Nov., to Fri., 2 Dec., at the Coliseum, New York. Organised by the International Exposition Co., 480 Lexington Avenue, New York 17, USA.

Corrosion and Metal Finishing Exhibition.—Tues., 29 Nov., to Fri., 2 Dec., at Olympia, London, W14. Organised by *Corrosion Technology*, Leonard Hill House, 9 Eden Street, London, NW1. Tel. EUSton 5911. (Change of title of the exhibition.)

Steels for Nuclear Reactor Power Circuits, Symposium.—Wed., 30 Nov., to Fri., 2 Dec., in the Hoare Memorial Hall, Church House, Great Smith Street, London, SW1. Will be included in the activities of the British Nuclear Energy Conference, of which the Iron and Steel Institute is a member. Organised by the Iron and Steel Institute, 4 Grosvenor Gardens, London, SW1. Tel. SLOane 0061.

Reinforced Plastics, Second International Conference.—Wed., 30 Nov., to Fri., 2 Dec., at the Café Royal, 64 Regent Street, London, W1. Organised by the British Plastics Federation, 47-48 Piccadilly, London, W1. Tel. REGent 2041.

Caravan Exhibition, Second International.—Wed., 30 Nov., to Tues., 6 Dec., at Olympia, London, W14. Apply to the organiser, Caravan Exhibition, *Daily Mail incorporating the News Chronicle*, Bouverie Street, London, EC4. Tel. FLEet Street 5000.

Institute of Marine Engineers.—*Annual Conversaziones:* Fri., 2 Dec., and Fri., 16 Dec., at Grosvenor House, Park Lane, London, W1. *Annual Dinner:* Fri., 10 Mar., 1961, at Grosvenor House, Park Lane, London, W1. *Annual General Meeting:* Tues., 25 April, 1961, at 76 Mark Lane, London, EC3. Offices of the Institute, Memorial Building, 76 Mark Lane, London, EC3. Tel. ROYal 8493.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., 5 Dec., to Fri., 9 Dec., at Earl's

Court, London, SW5. Apply to the secretary, Smithfield Show Joint Committee, c/o Society of Motor Manufacturers and Traders, Forbes House, Halkin Street, London, SW1. Tel. BELgravia 6611.

Hot Laboratory and Equipment Conference, Eighth.—Sun., 11 Dec., to Wed., 14 Dec., in San Francisco, California, USA. Will be held simultaneously with the winter meeting of the American Nuclear Society and in conjunction with the nuclear industry exhibit and meeting of the Atomic Industrial Forum. Apply to the secretary, American Nuclear Society, 86 East Randolph Street, Chicago 1, Illinois, USA.

Wholesale Buyers' Gift Fair, Second.—Mon., 12 Dec., to Thurs., 15 Dec., at Mount Royal Hotel, Marble Arch, London, W1. Organised by Trade Promotion Services Ltd., St. Dunstan's House, Carey Lane, London, EC1. Tel. MONarch 0871.

Statistical Mechanics (with Special Reference to Irreversibility), Conference on.—Mon. and Tues., 19 and 20 Dec., at Queen Mary College, Mile End Road, London, E1. Organised by the Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW1. Tel. BELgravia 6111.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Diagnostic Applications of Ultrasonics," by T. G. Brown. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 9 Nov., 6.30 p.m.*

NEWCASTLE UPON TYNE
"Distribution of Sound and Television by Wire," by A. W. Mews. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 9 Nov., 6 p.m.

WOLVERHAMPTON
"Modern Computer Techniques," by K. C. Johnson. West Midlands Section. College of Technology, Wulfruna Street, Wolverhampton. Wed., 9 Nov., 7.15 p.m.

British Interplanetary Society

BIRMINGHAM
"Radio Communication with a Space Probe," by W. T. Blackband. Midlands Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Sat., 12 Nov., 6.30 p.m.

East Midlands Metallurgical Society

DERBY
"Diecasting," by Dr. A. Street. Derby and District College of Art, Derby. Thurs., 10 Nov., 7.30 p.m.

Illuminating Engineering Society

LONDON
"Twenty-Five Years of Stage Lighting," by F. P. Bentham. Federation of British Industries, 21 Tothill Street, SW1. Tues., 8 Nov., 6 p.m.

SHEFFIELD
"History of Lighting," by J. W. T. Walsh. Sheffield Centre. Grand Hotel, Sheffield. Mon., 14 Nov., 6.30 p.m.

Institute of Marine Engineers

LONDON
"Construction and Layout of Modern Ships," by R. S. Hogg. Student Lecture. Mon., 7 Nov., 6.30 p.m.*
"General Developments in Ceramics for Marine Engineering," by F. J. Aldred and N. W. Hinchliffe. Tues., 8 Nov., 5.30 p.m.*
"Marine Electrical Engineering," by D. Gray. Junior Lecture. East Ham Technical College, Barking Road, E6. Tues., 8 Nov., 7.30 p.m.

BATH
"Distillation for Marine Purposes," by Commander R. G. J. Peaver, to be presented by Capt. W. R. Stewart. West of England Section. Smith's Assembly Rooms, Westgate Buildings, Bath. Mon., 14 Nov., 7.30 p.m.

LIVERPOOL
"Manufacture and Maintenance of Propellers," by J. M. Langham. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Mon., 7 Nov., 6 p.m.

Institute of Metals

BIRMINGHAM
"Modern Rolling Mill Practice": discussion. Birmingham Local Section. College of Technology, Gosta Green, Birmingham. Thurs., 10 Nov., 6.30 p.m.

SWANSEA
"Metals in High-Speed Flight," by Professor A. J. Kennedy. South Wales Local Section. Metallurgy Department, University College, Singleton Park, Swansea. Tues., 8 Nov., 6.30 p.m.

Institute of Physics and the Physical Society

LONDON
"Some Problems of Colour Reproduction in the Cinema," by L. B. Happé; and "Problems in Printing Colour Negatives," by J. Vickers. Colour Group. Physics Department, New Physics Building, Imperial College, Prince Consort Road, SW7. Wed., 9 Nov., 3 p.m.

Institution of Chemical Engineers

LONDON
"Dynamic Response of a Distillation Column," by W. D. Armstrong and R. M. Wood (two papers). Geological Society, Burlington House, Piccadilly, W1. Tues., 8 Nov. 5.30 p.m.*

Institution of Civil Engineers

LONDON
"Some Contributions from Nuclear Power to Engineering Practice," by Ian Davidson. Tues., 8 Nov., 5.30 p.m.*
"The Economics of Airlifts for Major Construction": informal discussion to be introduced by P. Wainwright. Thurs., 10 Nov., 5.30 p.m.*

Institution of Electrical Engineers

BIRMINGHAM
"A Survey of Street Lighting and Its Future," by W. R. Stevens and H. M. Ferguson. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 7 Nov., 6.30 p.m.*

GLASGOW
"The Digital Computer," by Dr. I. Cockrane. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 9 Nov., 6 p.m.*

MANCHESTER
"Submersible Pumping Plant," by H. H. Anderson and W. G. Crawford. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 8 Nov., 6.15 p.m.

NEWCASTLE UPON TYNE
"Water-Turbine-Driven Induction Generators," by C. L. C. Allan. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 7 Nov., 6.15 p.m.*

Institution of Engineering Designers

NEWCASTLE UPON TYNE
Films exhibited by Thos. Firth and John Brown Ltd. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 7 Nov., 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Axial Vibration in a Single-Screw Cargo Ship," by Dr. A. J. Johnson and W. McClimont. Tues., 8 Nov., 6.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Fuel Injection, Combustion and Noise": four papers, by Dr. A. E. W. Austen, B. E. Knight, Dr. W. T. Lyn and Dr. T. Priede. Automobile Division. Tues., 8 Nov., 4.30 p.m.

LEEDS
"Some Developments in the Nuclear Field," by A. T. Bowden. Yorkshire Branch. The University, Leeds. Thurs., 10 Nov., 6.30 p.m.

LUTON
"Inspection of Nuclear Power Plants," by H. N. Pemberton and E. Crossley. Eastern Branch. Joint Meeting with the Graduates' Section. Royal Hotel, Luton. Thurs., 10 Nov., 7.30 p.m.

NEWCASTLE UPON TYNE
"Economic Distribution of Steam," by J. A. Robins. North Eastern Branch. Stephenson Building, Claremont Road, Newcastle upon Tyne. Mon., 7 Nov., 6 p.m.

Institution of Plant Engineers

BRISTOL
"Modern Engineering Insurance," by K. J. Roberts. Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 9 Nov., 7.15 p.m.

GLASGOW
"Planned Lubrication in a Modern Steelworks," by John Stewart. Glasgow Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Thurs., 10 Nov., 7.15 p.m.

LEICESTER
"Industrial Power Generation," by A. Wheating. Leicester Branch. Midland Hotel, Leicester. Wed., 9 Nov., 7.30 p.m.

MANCHESTER
"Pressure Vessels," by C. W. Scarisbrick. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 8 Nov., 7.15 p.m.

Institution of Production Engineers

LONDON
"Health Services in Industry," by Professor R. E. Lane. The 1960 Sir Alfred Herbert paper. Royal Institution, 21 Albemarle Street, W1. Thurs., 10 Nov., 6.30 p.m.* (Tickets required.)
"Induction Heating," by D. G. Jones. London Graduate Section. Wed., 9 Nov., 7.15 p.m.

COLCHESTER
"The Practical Application of Production Engineering Research," by Dr. D. F. Galloway. Ipswich and Colchester Section. Golden Lion Hotel, Cornhill, Ipswich. Fri., 11 Nov., 7 p.m.

DONCASTER
"Current Management Thinking on Personnel Problems," by R. J. Stevenson. Doncaster Section. New Technical College, Doncaster. Tues., 8 Nov., 7.30 p.m.

LEICESTER
"Machine Tool Control," by C. J. Charnley. Leicester Section. Grand Hotel, Leicester. Thurs., 10 Nov., 7.15 p.m.

Institution of the Rubber Industry

LONDON
"Rubber in Engineering," by P. B. Lindley, at 5.30 p.m.; and "Mechanics of Attack of Rubber by Ozone," by Dr. A. N. Gent and M. Braden, at 7 p.m. Manson House, 26 Portland Place, W1. Tues., 8 Nov.

SOUTHAMPTON
"Supply of Chemicals for the Rubber Industry," by L. M. Dadson. Southern Section. Polygon Hotel, Southampton. Wed., 9 Nov., 7.30 p.m.

Institution of Structural Engineers

LONDON
"The 16 in ERW Tube Plant at Shotton," by W. T. Brooks, T. Burnet-Stuartt and G. B. Godfrey. Thurs., 10 Nov., 6 p.m.*

EDINBURGH
"The Relationship Between Architect and Structural Engineer," by W. Underwood. Scottish Branch. Adelphi Hotel, Coburn Street, Edinburgh. Tues., 8 Nov., 6.15 p.m.

Junior Institution of Engineers

LONDON
"Railway Signalling Problems in 50 Cycle Traction Areas," by H. J. N. Riddle. Fri., 11 Nov., 7 p.m.*

King's College, London

LONDON
"Vibration Mills and Vibration Milling," by Dr. H. E. Rose. Wed., 9 Nov., 5.30 p.m. (Tickets not required.)

Liverpool Metallurgical Society

LIVERPOOL
"Metallurgical Problems Associated with Mild Steel Strip," by E. D. Harry. Department of Metallurgy, The University, Liverpool. Thurs., 10 Nov., 7 p.m.

London Association of Engineers

LONDON
"Practical Metrology," by Dr. J. C. Evans. Junior Army and Navy Club, Whitehall Court, Horseguards Avenue, SW1. Sat., 12 Nov., 6.30 p.m.

Manchester Metallurgical Society

MANCHESTER
"Casting," by Dr. D. V. Atterton. Manchester Literary and Philosophical Society, George Street, Manchester. Wed., 9 Nov., 6.30 p.m.

Pipeline Industries Guild

LONDON
"Prestressed Concrete Pipes," by W. Boden (with film). Caxton Hall, off Victoria Street, SW1. Tues., 8 Nov., 6.30 p.m.

Reinforced Concrete Association

MANCHESTER
"Multi-Storey Car Park," by E. N. Underwood. North Western Branch. Joint meeting with the Institution of Structural Engineers. College of Technology, Sackville Street, Manchester. Wed., 9 Nov., 6.45 p.m.*

Royal Institution of Chartered Surveyors

LONDON
Presidential Address, by J. D. Trustram Eve. Mon., 14 Nov., 5.45 p.m.

Royal Society

LONDON
"Progress and Needs of Marine Science," discussion meeting under joint leadership of G. E. R. Deaton and F. S. Russell. Thurs., 10 Nov., 10.30 a.m. and Fri., 11 Nov., 10.30 a.m.

Royal Society of Arts

LONDON
"Training of Officers for the Merchant Navy," by Captain G. W. Wakeford. Wed., 9 Nov., 2.30 p.m.

Royal United Service Institution

LONDON
"Australia and Her Place in the World," by Field Marshal Sir William Slim. Wed., 9 Nov., 3 p.m. (Members only.)

Society of Engineers

LONDON
"The Heat Pump in Great Britain," by Miss M. V. Griffith. Geological Society, Burlington House, Piccadilly, W1. Mon., 7 Nov., 5.30 p.m.*

Society of Instrument Technology

LONDON
"A Shaft Position Digitiser Using Synchros," by T. Roberts. Data Processing Section. Manson House, 26 Portland Place, W1. Wed., 9 Nov., 7 p.m.*

BIRMINGHAM
"The Common Sense Approach to Instrument Manufacture," by C. E. T. Cridland. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 11 Nov., 7 p.m.*

LIVERPOOL
"Some Recent Advances in Radiation Pyrometry," by B. W. Barley. Liverpool Section. Industrial Development Centre, Midlands and North Western Electricity Board, Liverpool. Thurs., 10 Nov., 7 p.m.

Television Society

LONDON
"Masers and Parametric Amplifiers: Their Use in Ultra-Low Noise Receivers," by C. R. Russell. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Thurs., 10 Nov., 7 p.m.

Women's Engineering Society

LONDON
"Railway Modernisation and Electrification," by E. C. Cookson and A. H. Emerson. London Branch. Hope House, 45 Great Peter Street, SW1. Wed., 9 Nov., 7 p.m.*

MANCHESTER
"An Introduction to Professional Engineering": Discussion. Manchester Branch. 46 Fountain Street, Manchester 2. Wed., 9 Nov., 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
British Interplanetary Society, 12 Bessborough Gardens, London, SW1. (TATe Gallery 9371)
East Midlands Metallurgical Society. Apply to Mr. E. D. Knights, 10 Penrhyn Avenue, Derby.
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, Londcn, SW1. (VICtoria 0786)
King's College (University of London), Strand, London, WC2. (TEMple Bar 5454)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
London Association of Engineers, 5 Wimborne Grove, Watford, Hertfordshire. (Gadebrook 2995)
Manchester Metallurgical Society, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
Pipeline Industries Guild, 7 Iddesleigh House, Caxton Street, London, SW1. (ABBey 6925)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Institution of Chartered Surveyors, 12 Great George Street, London, SW1. (WHItehall 5322)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5824)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

Put Electrostatics to Use

The electrostatic machine has been re-born. In both machines and applications, advances have recently been made which may have a considerable impact on industry.

INVENTED several hundred years ago, the electrostatic generator has had a varied and remarkably unprosperous career. During this time it has been periodically taken up and then abandoned as a useful source of electrical energy. In fact, until quite recently only a few worthwhile machines have been developed (such as the Van de Graaf), and then only with very limited scope.

In more recent years, however, a number of engineering scientists have devoted considerable attention to the further development of electrostatic techniques. As a result of their efforts, not only have machines with greater efficiencies and reliability been developed, but the whole concept of electrostatic techniques has changed.

What was yesterday considered to be an unwieldy laboratory gadget has today emerged as a well-engineered "tool," with considerable potential for industry. In fact, research has reached the stage where serious thought is now being given to the possibility of producing moderately large-scale power with electrostatic machines. Already, a proof-of-principle model has reached powers of several kilowatts (at 50 kV), and feasibility studies have shown that up to 50 kW could be achieved with existing techniques.

At a time when contemporary thoughts on power transmission are tending toward the increased use of direct current, the idea of generating d.c. power at high voltage opens up some interesting possibilities.

A PLACE IN INDUSTRY

World-wide recognition of the great strides forward that have been made in electrostatic techniques came only quite recently, when the 1st International Colloquium on Electrostatic Forces and Their Applications was held, in Grenoble, France. At this meeting, for the first time ever, the world's foremost authorities and protagonists of the science of electrostatics met to exchange ideas: and, again for the first time, it became apparent that the electrostatic device has finally begun to take its place in the world of industry and engineering.

For the past few decades, research has been progressing steadily in several centres throughout the world, particularly in America and France, but has been achieving only local recognition. For instance, the Felici generator (ENGNG., 10 April '59, p. 466) has been used relatively little outside France in spite of its truly outstanding technical features. Similarly, development work on precipitation, which has had successful application in both steam generating plant and steel furnaces in America has not yet achieved full recognition elsewhere.

There are two distinct reasons why electrostatic techniques have so far had a cool reception from industry. First of all electrostatic generators have a poor reputation for reliability; which is not at all surprising since the average engineer's concept of such machines is based on his schoolday experiences with a Wimshurst device. Secondly, engineers have a natural dislike for high voltages because, in nearly all cases, they are dangerous.

SAFE AND RELIABLE

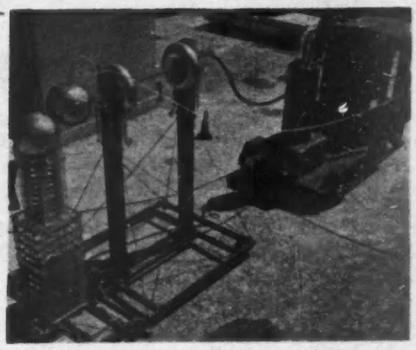
However, in the light of recent advances, complete re-thinking is now required on both these issues. To begin with, the Felici generator (which can produce voltages up to 1·2 Mv) is as reliable as any normal piece of rotating machinery and can work continuously for thousands of hours with negligible maintenance. In the second case, unlike other sources of high voltage, the Felici machine has very low electrical capacitance, so that the danger of high-voltage shock has been reduced by orders of magnitude. In fact, the output terminal of the 150 kV, generator manufactured by SAMES of France can be touched with no ill effect.

Already these new factors have brought about a minor revolution in one of industry's most basic operations, i.e., paint spraying. Although it is true that the advantages of charged-particle spraying have been realised for some time, the safety and reliability factors have until now prevented its widespread use. The technique offers substantial improvements in speed, efficiency and efficacy (ENGNG., 23 Sept. '60, p. 418) and there is every indication that it will supersede ordinary pneumatic methods.

Other types of liquid, and even fine dust particles may also be sprayed electrostatically with considerable advantage. A good example is crop spraying which, when done by normal physical methods, is often very inefficient because the insecticide particles do not adhere to the crops effectively. Not only does the insecticide normally get washed and blown away by rain and wind, but a large amount of it is often wasted by unnecessarily spraying the surrounding earth. By using the electrostatic method, however, insecticide particles are attracted almost exclusively to the plants, wrapping themselves around the foliage by virtue of their mutual repulsion, and remaining there due to the electrostatic forces of attraction between plant and charged insecticide.

The fact that insecticides may now be used more efficiently may well open up new markets for the manufacturers, particularly in cases where the high cost of such operations has previously outweighed their effectiveness.

Widespread realisation of the powers of electrostatic attraction and repulsion, which have now been harnessed with a high degree of reliability, will inevitably lead to the development of new industrial techniques; some superseding existing methods and others being unique.

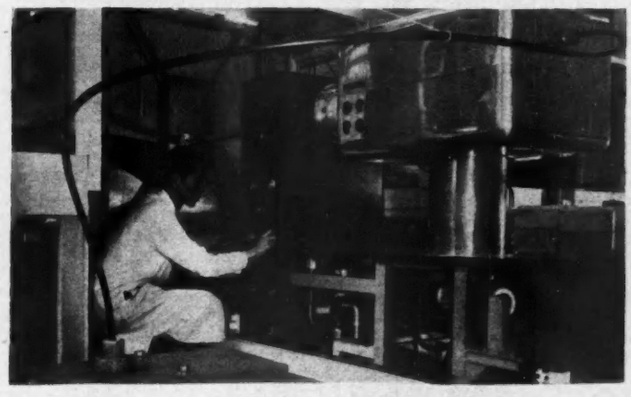


A portable unit, containing a 600 kV SAMES generator, is being used in America for testing cables at high voltage.

An example of this has already emerged in the form of an electrostatic chuck for holding workpieces during machining operations. By using the forces of electrostatic attraction, this chuck can succeed where the electro-magnetic chuck fails, i.e. on non-ferrous materials such as aluminium, brass, copper, beryllium, titanium; and many other currently used metals. Furthermore, since the electrostatic technique relies entirely upon surface phenomena, very thin sections can be held with the same force of attraction as thick ones. This means that ferrous metal workpieces with insufficient volume to accommodate a large number of magnetic flux lines can be firmly held electrostatically.

As there are no poles or pole pieces on the electrostatic chuck, uniform holding power is developed over the entire surface. Therefore small parts can be gripped without regard to the location. There is also the advantage that no residual magnetism is developed by this method, consequently the often arduous operation of demagnetising is completely eliminated.

The electrostatic device has, particularly since the development of the Van de Graaf generator, been quite firmly entrenched in the realms of high energy physics. In fact it is due only to these physicists, some of whom are extremely competent engineers as well, that the electrostatic machine has been successfully nursed through its long and delicate infancy. However, in spite of the near-genius work that has gone into this development, there is still a long way to go before electrostatic techniques reach full maturity. The time has now come when the technological resources of industry are needed to back up the work of the dedicated few, so that industry itself can reap the rewards of a new and vital source of energy.



Research workers at Queen Mary College, London, are currently using a SAMES 150 kV Felici electrostatic generator to provide a pulsed neutron source for kinetic experiments with a sub-critical reactor.

Modernisation Needs Modern Railwaymen

Failure of British Railways to recruit a sufficient number of qualified engineers not only jeopardises the modernisation plan but may also lead to backwardness in other areas of engineering. The author is a member of the Select Committee on Nationalised Industries.

By Austen Albu, B.Sc., A.M.I.Mech.E., M.I.Prod.E., M.P.

THE British Transport Commission for all its services employed in 1959 a total of 1,535 professionally qualified engineers, of whom only 512 were graduates. Of this total the number of mechanical engineers had actually gone down since 1956 from 598 to 484. The 1,354 qualified scientists and engineers of all types employed by British Railways alone represented less than 0·3 per cent of all railway employees.

This failure to recruit an adequate technical staff has been recognised as one reason for the delays in the Railways Modernisation Plan. This disclosure, which has so far received little attention, was made in the Report of the Select Committee on Nationalised Industries, and the evidence now published is worth study by those concerned with the problems of modernising an industry steeped in tradition.

The Modernisation Plan envisaged three radical technical changes in the equipment of the railway system: (1) the improvement of track and signalling so that higher speeds and better utilisation of equipment would be possible; (2) the replacement of steam as a form of motive power by electric or diesel traction, and (3) the replacement or modernisation of passenger rolling stock and the improvement of passenger stations and parcel depots.

As this plan involved the first large-scale investment of capital in the railways in living memory, it could be assumed that many changes in materials and ancillary equipment would be incorporated in addition to the major changes in the traction and signalling sytsems. The whole new world of electronic control had come into existence since the war and large numbers of new light-metal alloys, high-quality steels and synthetic materials were available to designers.

A new and more scientific approach to the problems of design and operation was going to be required from the railways' technical staff and the numbers of qualified engineers needed could have been expected to be much greater. To some extent the need for more staff was recognised by the Commission, who stated in their Plan that there were staff shortages; that an energetic policy of recruitment would have to be adopted and that shortage of expert staff should not constitute an obstacle to the achievement of the Plan. The Select Committee's Report makes it clear that in this aim the Commission have dismally failed.

ELECTRICAL HAZARD

The most serious shortage is in electrical engineers, of whom the number employed in 1959 was only 277 by the BTC as a whole. In particular, the shortage of signal engineers, notwithstanding the use of consultants and recruitment on the Continent, has forced concentration on the electrification of the London Midland line at the expense of other schemes. Witnesses before the Select Committee claimed that technical staff as a whole had increased by a third in the last four years, but, according to the White Paper, the numbers holding Higher National Certificates or Diplomas in mechanical and electrical engineering had only risen from 523 to 624. The Committee concluded that the increase in technical staff had been, in the main, in those lacking any formal qualification.

A Select Committee of Members of Parliament is not an expert body capable of making an accurate assessment of the numbers and quality of staff required by a large enterprise or of the nature of the tasks that they should perform. Nevertheless, the Committee expressed the view that the shortage of qualified technical staff in the field of design had clearly affected the Commission's operations during the period of modernisation.

They quoted as an example a mistake in the design of vacuum brakes for mineral wagons. The chosen brake gear failed to allow for the various tipplering devices used by the Commission's customers and themselves. As the mineral fleet comprises more than half the railway's freight vehicles, and the adoption of continuous brakes was one of the most important advances contemplated in the Modernisation Plan, this failure has been an expensive one.

The Committee also draw attention to the lack of preparation for the large-scale use of diesel locomotives before the start of the Plan. British Railways' diesel experience had been effectively limited to shunting locomotives and the Commission's witness admitted that if they had bought 50 locomotives in 1950 instead of 5 they would have been in a much better position to expand. The decision which the Commission took was to design the frames and running gear themselves and to rely on private industry to design the power and traction equipment and control gear. As a result, the design of diesel locomotives has been divided and largely in the hands of men whose only experience has been in steam. The Commission admitted that they had had trouble with the bogies of the new electric rolling stock on the Southern Region—a matter on which considerable research might have been expected. Unfortunately not much in the way of research facilities was inherited by the Commission and the amount of research carried out was admitted by the Chairman to have been quite inadequate.

One result of the shortage of qualified technical staff has been that the railways have had to rely to a great extent on outside consultants for design and planning. Because of this it appears that the Commission have had some difficulty in achieving standardisation of signalling equipment, owing to the competitive interests of the three firms from whom they purchase.

PURCHASING IN THE DARK

Although the Commission's witness thought that the design of electrical equipment was best left to the staffs of the supplying firms he admitted that if they had had enough specialised staff themselves they could have insisted that the companies supply to the Commission's own specifications. There were echoes here of the Howitt Report on the Purchasing Procedure of the BTC which was submitted in 1957. This was a report on the allegations made by a former supplies and production adviser to the Commission about the purchases of certain stores such as vacuum brake cylinders and signalling equipment and the placing of contracts for overhead electrification.

It was clear from this report that, being short of technical staff, the Commission had been in a weak position as a purchaser. From the latest figures of staff quoted by the Select Committee it would seem that the Commission is in an even weaker position today.

In view of these admitted inadequacies it is surprising how little understanding the Commission's witnesses showed of the scale of the problem with which they were faced; so much so that the Committee said that they were not satisfied that the Commission had treated it with the urgency it deserved. The truth is that the railways have always been among the most conservative of British industries in their methods of recruiting engineers. In this they are representative of, and in some degree responsible for, the attitude common to a large part of the mechanical engineering industry.

When the writer was a mechanical engineering student in the '20s the heroes of the profession were the chief mechanical engineers of the railways; those great men who designed and built the superb and thermodynamically inefficient monsters of the steam age.

Much of the engineering industry grew up to supply the requirements of the railways and took as its model their standards and methods of training. The machine-tool industry is a good example and so, in a related field, is shipbuilding. The method of training was the traditional one; indentured apprenticeship and evening classes, leading eventually to the coveted corporate membership of the Institution.

In its day this method produced many first-class engineers, but its day was already waning at the turn of the century and was only given a new and false dawn by the introduction of the National Certificate system after the First World War. Today it is hopelessly inadequate for any industry which hopes to profit from the scientific and technical advances which are pouring out of the research laboratories, and which need for their understanding and application men with a university education or its equivalent.

It is pathetic, therefore, that the Commission should still believe that they can recruit professional engineers from the shop floor. They expressed disappointment that their apprentices did not move on from National Certificates to higher professional attainments, as if they had never heard of universal secondary education, of free grammar schools, of university student grants and of Diplomas in Technology.

FRUSTRATED TALENT

The facilities for training craft apprentices and technicians in British Railway workshops are first class, but the Commission have done less than many large industrial firms in providing whole-time or sandwich-course education for their own student apprentices. At the present time they have seven students in a sandwich course at Southampton University and 85 at technical colleges and colleges of technology. Of these only 17 are taking courses at professional level and a further 18 are taking Higher National Diploma courses.

The attitude of the Commission is all the more surprising because they themselves recognised the difficulty they would have in recruitment to what had been considered a contracting industry. One of the handicaps to recruitment has been the salary scale. The Commission claimed that the salaries offered to graduates were about equal to the middle range of industry. On this the Select Committee commented that, on the figures quoted, their top salaries in the middle range were 15 per cent below the average disclosed by the tables in the Report of the Royal Commission on Doctors' and Dentists' Remuneration. But salaries and the doubtful future of the railways may not be the only deterrents. It is said that many graduates find that they are not given the opportunity to use their talents and training in the railways design offices for the very high wastage of technical staff.

The Commission is understood to have been pleased with the Select Committee's Report which supported many of their contentions, such as the need for an integrated railway system, the desirability of proceeding with electrification and the unfairness of an accounting system under which they were expected to carry unprofitable social burdens without recompense. It is to be hoped that they will take as seriously the Committee's views on the recruitment of technical staff.

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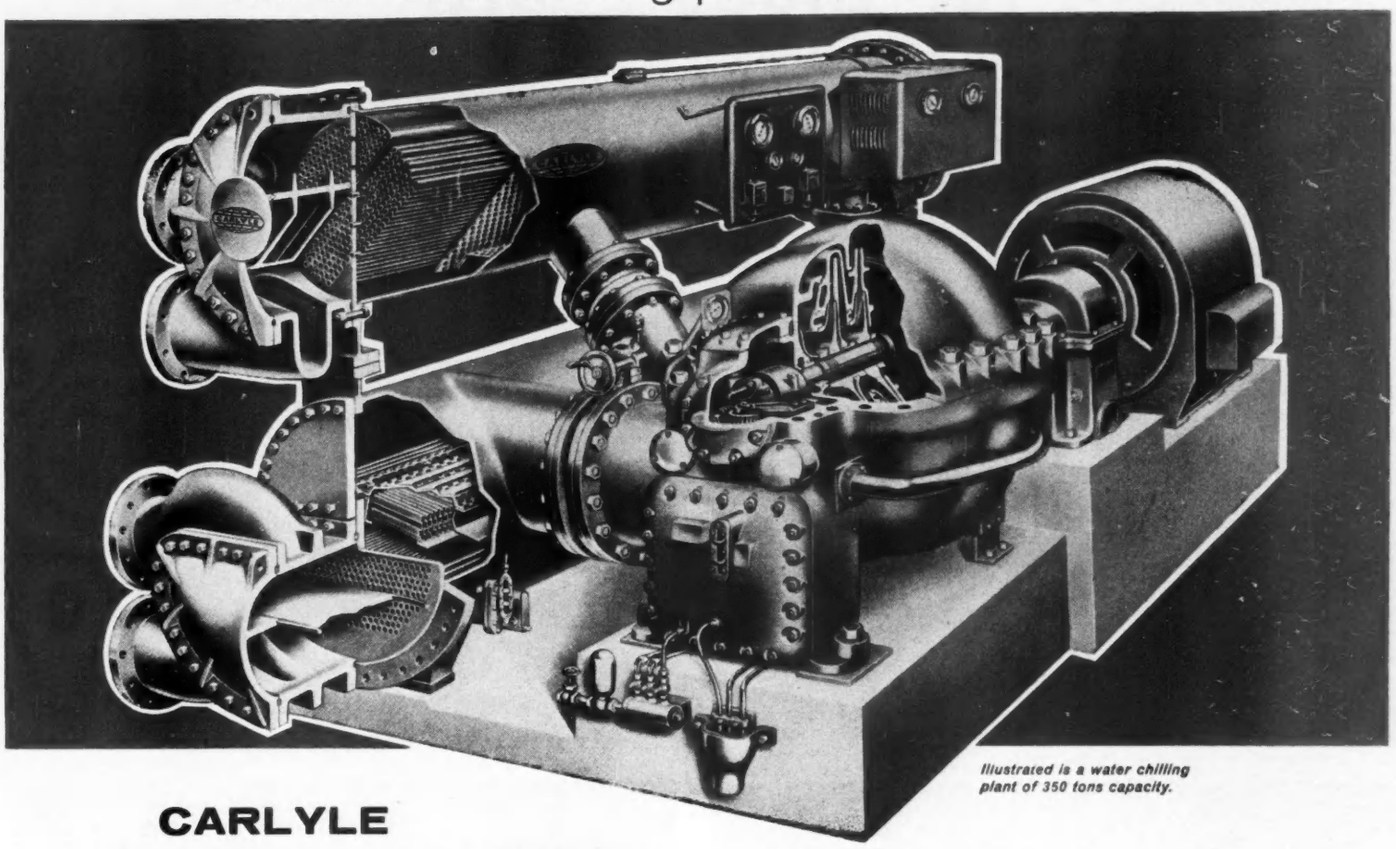

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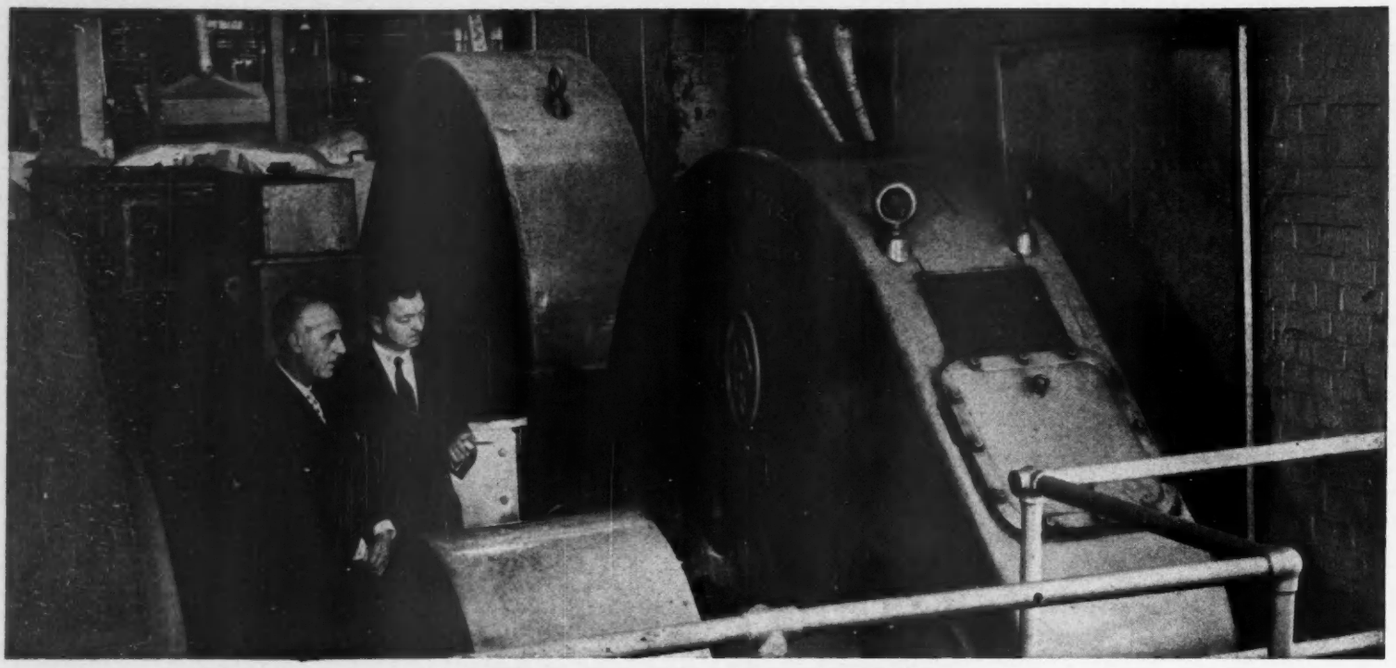

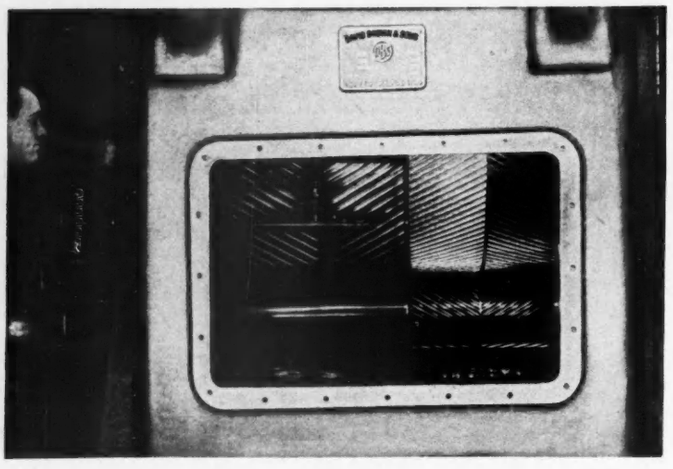

(Top) Regent Sales Engineers at the Dunlop factory, Birmingham.
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Human Element

Rail Unions in Unison on Railway Policy

THE three rail unions, all unconsulted about the findings of the Stedeford committee on the decentralisation of the British Railways, are in practical agreement on the main points of railway policy.

At a recent joint meeting the three unions came out against any extension of the authority of the six regional boards, a step which it is believed may be recommended by the Stedeford committee. The unions would also like to see the Transport Tribunal abolished and they would like to see a new approach to planning in order to put the railway modernisation scheme through as quickly as possible.

Taking up a position which in important respects is parallel to that of the Select Committee on Nationalised Industries which looked into the British Railways, the unions are also against any separation from the nationalised industry of profitable sectors like the docks, hotels and road transport.

Opposition

The three unions are the Transport Salaried Staffs Association, the Amalgamated Society of Locomotive Engineers and Firemen, and the National Union of Railwaymen. The NUR has already come out against what are believed to be the main points of the Stedeford committee's secret report to the Minister of Transport and the British Transport Commission.

It has not been seriously denied that morale in an organisation as widespread as the British Railways is almost as important a factor as the effectiveness of the equipment. Treating the report of the committee as something to be guiltily hidden away and acted upon in brusque, unilateral fashion is to throw out the reasonable chance that by discussing the report with the union leaders a basis could be laid for subsequent cooperation when the times comes for its implementation.

Unless of course it is the intention of the Minister of Transport to put certain changes through following the Stedeford report, whatever may be its detailed conclusions.

One Reason for Avoiding Australian Contracts ?

Sir Eric Harrison, the Australian High Commissioner in London, was recently appealing for British industry to take a greater interest in Australia's expanding economy. He cited the case of one important development project where only one tender was received from a British company.

With this still fresh in the mind it was revealing to encounter on a recent train journey an engineer of ten years experience in Australia, who was strongly vocal, in a despairing way, about the difficulties civil contractors meet there with the attitude adopted by the workers.

This was admittedly only one man, but his experience had been that the casual, do-it-tomorrow, attitude made working to dates a very difficult, and costly, business. Over-frequent official inspection with consequent delays while the arrival of the inspectors is awaited was another complaint.

It is possible that one man may take too gloomy a view of a problem. The same engineer had, after all, decided that after his return visit to Britain, he was going back to Australia and the outdoor life.

Keeping the Coast and Hiding the Wires

Given unlimited funds the National Trust would put at the head of its priorities the preservation of certain coastal areas and the placing of wires underground.

Both problems are of serious and urgent nature as new building, both for industry and for homes, occupies more and more of the country.

Four thousand acres of the Cornish coast have been acquired over the past ten years, either through bequests or by gifts of money for the specific purpose. While so much good work has been done in Cornwall, there are stretches of splendid and distinctive coastline in Dorset, Devon, Northumberland, Suffolk and Pembroke where spoliation could still take place. But the Trust has very limited funds. It is well able to point out the problem, much less well provided to apply the remedy.

Caravan Erosion

And the answer is clear enough. Much of the coastal area in the far south-west has been taken into the permanent care of the Trust. With the direct result that those who spend most of their lives hard at work in exclusively urban surroundings, shall have somewhere to go to relax and get away from the constant pressures without being always in sight of caravan parks and bungalows for the retired.

It is nothing less than an important national need that the Trust should have something more than private gifts to use in preserving very much more of the coastline than has yet been possible. An increasing proportion of the population is able to get away to the Mediterranean for an annual holiday. But for the week-ends, and for the simple fact that they are there, the English coastal areas that have not yet been caravaned into chaos deserve to be brought under protection.

The unsightly wires festooning the country are an even more difficult problem. With the best will in the world the electricity authorities could not put them underground without substantially increasing the installation costs of the distribution system. It is hardly part of their brief to push the costs up in this way.

But that only shows that the problem is above the level of the electricity chiefs. Britain is not a country that conducts national referendums but it would be worth knowing whether or not a majority of people would be willing to pay a little more for their electricity in order to put the wires underground, do away with the astonishingly ugly pylons and make a start back towards England as a "green and pleasant land."

Since there is no sign of this happening perhaps the responsible board might commission a competition for pylons that made some concession to their unavoidable obviousness.

Advanced Automobile Engineering Course

Twelve young Leyland Motors Company employees are now in the thick of the first term of a company scheme for advanced automobile engineering.

The course has three aims. They are to link up theoretical knowledge of holders of the Higher National Certificate, Higher National Diploma or Diploma in Technology with the practical problems of designing heavy duty vehicles and to shorten the time required to gain the practical experience necessary for successful design; to find men who have the aptitude, and wish, to specialise in unit design; and to enable those with outstanding design ability to show their potentialities for future development.

Need for Revision

Since all Leyland's executives in the Engineering Division must be designers and engineers of special ability it follows that success on the course will be a qualification when future selection for higher executive positions is being made. A more short term reward, and further valuable training, will be the three months travelling scholarship in the United States for the student gaining first place in the final examination next spring. The second and third place students will be offered travelling scholarships for a month in Europe.

It was found in the pilot course that parts of the Higher National Certificate syllabus which form an essential basis for the course were not thoroughly known by all the students. In order to spend none of the course doing revision the students were told two months before beginning the scheme that they had been accepted and were expected to revise the appropriate parts of the HNC syllabus.

Mr. V. W. Pilkington, the Leyland technical director is acting as director of studies for the course. His introductory lecture was on "The Designer and Company Policy." Mr. J. McHugh, the chief engineer (vehicles) is lecturing on chassis design, Mr. N. Tattersall, the chief engineer (engines) on the power unit, and there are other company engineers lecturing on transmissions and materials.

Surprise Candidates for TUC Post

Those who thought that Mr. Victor Feather, the widely respected assistant secretary to the Trades Union Congress, was going ahead unopposed to the higher post of assistant general secretary have had the surprise of learning that two other members of the TUC staff had put themselves forward for the position.

They are the head of the production department, Mr. E. Fetcher, and the head of the economic and research department, Mr. L. Murray. Since the position which Mr. Feather now holds is being abolished, it has been thought that he would automatically be going on into the post left vacant by the advancement from assistant general secretary to general secretary of the TUC of Mr. George Woodcock.

The Council's finance and general purposes committee interviewed all three candidates before making a recommendation to a meeting of the General Council. In deciding in favour of Mr. Feather, the finance and general purposes committee, who were of course aware that his existing post would no longer be there, have come down in favour of the combination as before.

Electronic Application Assists the Blind

Each year some 12,000 people have their names entered on the register of blind persons. For them, as for those who have been blind from birth or simply have been struggling with the problems of the sightless for a long period there are 200 voluntary organisations, most of them local in character, working with the local authorities and the Government departments, on care and the provision of services.

Supplementing both local voluntary and Government services, the Royal National Institute for the Blind keeps the personal touch alive in its special services, provided throughout the country, and continues its pioneering work in methods of helping the blind to live as normal a life as is possible.

Its latest annual report shows how a quarter of a million pounds spent on producing Braille and Talking Books, almost as much on grammar and special schools and the famous Sunshine Homes, down to the £70,000 for general assistance, miscellaneous services and central administration, amounted to an Institute budget for the past year of £1,337,146.

The RNIB sticks closely to the spirit of the epitaph upon its founder, Dr. Armitage—"Friend of the blind."

And it knows that just as much as it is vital to the life of the blind that they shall be able to contribute to the life of the people around them, so it is important that they shall be able to play as well as to work. Traditionally, ball games for blind sportsmen have suffered from using a ball equipped with a bell that rings so long as it is in motion. When the ball comes to rest it also becomes silent—and the game loses its grip on the attention while the silent ball is sought.

Bleeper Ball

Now a ball with an electronic sounding unit housed in sponge rubber is being given intensive tests. The RNIB hopes that it will eventually lead to cricket and football being played by the blind with much more freedom, since the new ball gives out its bleeping sound whether in motion or at rest.

Physiotherapy is a field in which the Institute has had a particular success. It maintains its own School of Physiotherapy and is able to claim that Britain is far in advance of other nations in the equality of its blind physiotherapists with their blind colleagues.

For numbers of blind people retraining for a job reveals aptitudes which take them into various forms of light engineering industry. RNIB training colleges and certain Government training centres give training and there are companies ready to take blind workers into an equal place on their payroll alongside the sighted.

HYDRAULIC DITCHER

Tractor Mounting

THE Leeford ditcher is an attachment for mounting on an agricultural tractor for cutting and cleaning ditches.

The attachment fits the three point suspension of the tractor and can be fixed in 10 minutes. It consists of a main beam along which a bucket arm travels, and the bucket arm itself with the necessary hydraulic cylinders. The beam may be mounted on either side of the tractor and gives a maximum outreach of 16 ft.

Ditches can be up to 6 ft deep by 6 ft wide with straight or battered sides according to the type of bucket used. Three standard types are available; the Ministry of Agriculture version, 41 in wide at the top with 32 in sides tapering to 13 in at the bottom; a tile drain model with 16 in width, 2 ft 6 in depth and 8 in bottom width; and a model for rectangular trenches 18 in wide.

By means of a telescopic beam, the bucket will cut on a flat plane for a distance of 3 ft 9 in before lifting clear for ejection of the spoil. The full bucket

can be traversed to any point along the beam for ejection. When discharging, the bucket is moved through 270° against a fixed ejector plate so that all spoil is removed from it. Digging speeds depend on conditions, but up to 180 ft per hour is possible.

The completed trench is parallel to the line of the tractor movement and work can be carried out close against hedges or walls. For travel on roads the extension beam is unbolted and then placed on the front carrier assembly, in which position the tractor conforms to traffic regulations. *F. A. Hughes and Company Limited, 4 Stanhope Gate, London, W1.*

BLOW GUN

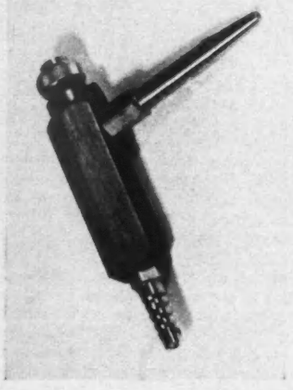
Adjustable Pressure

ON the Vario blow gun now available in this country the jet pressure is adjustable.

The gun is designed for use on any standard air line and has a standard hose connector. The nozzle is only 1·5 mm diameter at the tip and is 70 mm long so that it will reach into small spaces for detail cleaning. At the top is the operating button and the adjusting mechanism.

The nozzle is set at right angles to the body so that the jet can be directed easily on to the work. Condensation from the compressed air has no effect on the performance. The valve is made of nylon and is sealed by a spring and the force of the air. The body is made of light alloy.

Jet pressure regulation is obtained by screwing down the nut on the head. A small nylon cylinder, held pressed down on the thread of the regulator by a spring, ensures that the position is maintained as set. In this way light, medium or strong jets can be obtained.



With the regulator screwed right down a continuous jet is given at controlled pressure, whereas normally the jet only operates when the top button is depressed. Economy in the use of air is claimed. *Step Industrial Equipment Limited, Lower Kings Road, Berkhampstead, Hertfordshire.*

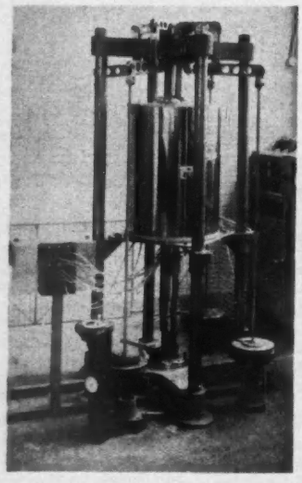
CREEP TESTING MACHINE

Multi-Specimen

UP to four high sensitivity tests or 12 fracture tests can be carried out simultaneously on a new creep testing machine.

The Unisteel uses a single furnace and a single controller. It incorporates four loading systems each of which caters for one high sensitivity test or three stress-to-fracture tests in series. The floor space required is slightly more than one square yard and machines can be sited at 4 ft centres. This allows a large number of testing stations to be set up within a comparatively small area.

Loads up to a maximum of three tons can be applied to a specimen. The complete unit comprises the machine itself; a furnace consisting of a fused silica tube, wire wound in three zones for resistance heating, encased in a polished stainless steel cylinder; a control panel incorporating an electronic temperature controller; and two auxiliaries—a ratchet spanner and a lifting jack—which can be used with a number of machines. For compact installations, guards can be



fitted to prevent accidental contact of the loading weights of one machine with another. *Distington Engineering Company Limited, Workington, Cumberland.*

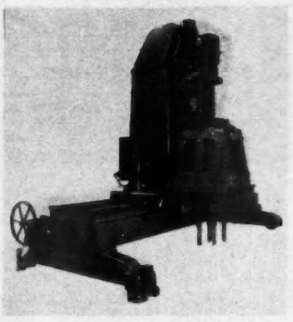
MULTI-SPINDLE DRILL

Bogie Carriage

TWO new multi spindle drilling machines have been produced both running on bogie carriages.

One has a single head as illustrated and the other is fitted with two drilling heads operating independently. The bogies are arranged to run on rails set at 15 ft centres and consist of a crossrail with accurately machined slideways, bolted to a bogie carriage with convex faced wheels at one end. At the other end is a roller bracket with guide rollers that close on the rail and so ensure alignment. Power traverse is provided by a 3 h.p. motor with worm reduction, and there is a hand wheel for fine setting.

The columns are box section and can be traversed along the slideways by hand wheels working through rack and pinion gearing. The drilling heads are mounted on the front of these columns, being balanced by a dead weight hung inside. The arrangement allows the complete drilling unit to be removed and remounted for work in the horizontal plane. The spindles are mounted in



pairs on slide ways which are manually adjustable in one direction from 0 to 6 in.

Each head comprises a D7D unit driven by a 12½ h.p. motor with pick-off gears for change of feed and speed. A four spindle multi-head unit is bolted to the drilling head and each spindle has adjustment for 1½ in to accommodate different drill lengths. The single head covers 18 in by 12 in with a traverse of 11 ft on the cross rail. *Kitchen and Wade Limited, Arundel Street, Halifax.*

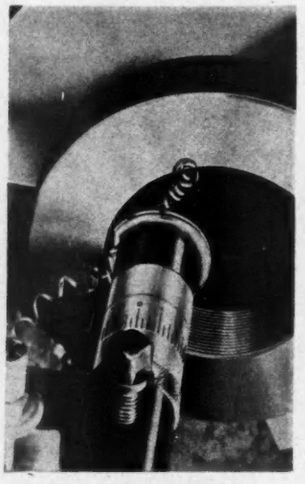
THREAD CUTTING TOOL

Adjustable

CUTTING tools for internal and external threads now available in this country are claimed to give accurate profiles free from burrs.

The internal type is illustrated. These have the cutter head set at an angle and the lead angle can be set to the required amount by rotating the knurled ring. There is also an adjustment to allow the cutting point to be set to the correct height following grinding.

The lead angle on the external cutter is set somewhat differently by a sliding member but the same range from 5° left to 5° right can be obtained. Two gauges are supplied with the tools, one for setting the grinding face angle and the other for positioning the cutting point. The length of the profile of a 2¾ in diameter tool is 8¾ in which allows grinding back for approximately 8½ in giving the tool a very long useful life. External tools in the MP range have discs of 1·97 and 2¾ in diameter and in the internal type of from 0·71 to 1·5 in approximately. The range of threads



is from 8 per inch to 32 per inch. *International Engineering Concessionaires Limited, 39 Parliament Street, London, SW1.*

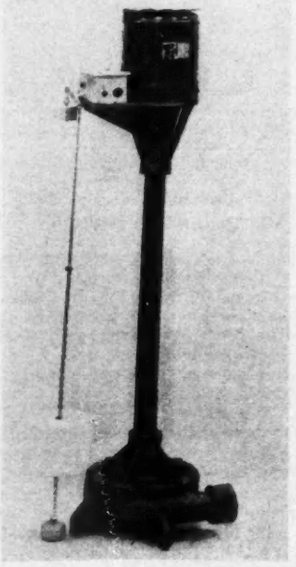
SUMP PUMP

for Occasional Solids

A CENTRIFUGAL pump type 4656M, will handle solids up to ¼ in diameter without damage or clogging.

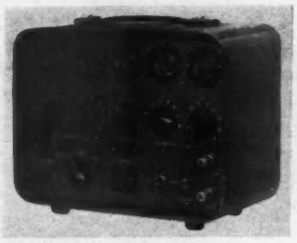
The pump is not intended for handling slurries and the bearing near the impeller is lubricated with water. Control is automatic by a float and the motor is rated continuously. It can be installed in a sump 18 in square and with a maximum depth of 2 ft 6 in. There are two versions: the one of ½ h.p. will deliver 75 gallons per minute at 9 ft head or 10 g.p.m. at 23 ft head; and the ¾ h.p. model 80 g.p.m. at 13 ft or 10 g.p.m. at 28 ft head.

The impeller is an open type design made of gunmetal. The shaft is stainless steel secured to the motor shaft by a muff coupling. The lower bearing is self lubricating bronze. The motor stool is identical for all sizes of single phase motors and is designed to carry the motor and mercury switch. The latter is operated by polystyrene floats. *Lee, Howl and Company Limited, Tipton, Staffordshire.*



CAMERA CONTROLLER

Intermittent Operation



TIME and motion study data are a typical application for the Intervalometer camera controller.

Single shot and high speed cameras can be fired and checked by the instrument over a wide range of time intervals. Alternative uses are for process controls where operations have to be initiated at set intervals. Time intervals from 1 sec to 100 min can be accurately checked in steps of 0·1 sec.

For accurate checking of frame speeds and accelerations of high speed cameras, a special photoelectric head is available. The probe is inserted into the camera replacing any size of lens by means of a taper plug. These checks can be made over periods from 0·1 sec to 9·9 sec. A 100 cycles pulse is available for time base marking of high speed runs using a neon tube.

One of the chief features is an adjustable output pulse length which permits most single shot cameras to be triggered. The variation of this output does not affect the reset time so that the overall accuracy of the controller is maintained.

The unit can also be used as a five decade counter with dekatron tubes displaying tenths, seconds, tens of seconds, minutes, and tens of minutes. A highly stable tuning fork oscillator ensures a time accuracy better than 0·05 per cent.

A switch selects the desired operation —interval, frame speed, or count. The instrument is designed to operate from a 24V d.c. supply and weighs only 12 lb, making it portable. A matching power supply unit is available to allow operation from the mains. *Aldersgate Electronics Limited, 66 Victoria Street, London, SW1.*

REINFORCING MACHINE

for Flexible Hose

REINFORCING wires for flexible hoses can be laid in spiral layers by the Pre-Spiroflex machine.

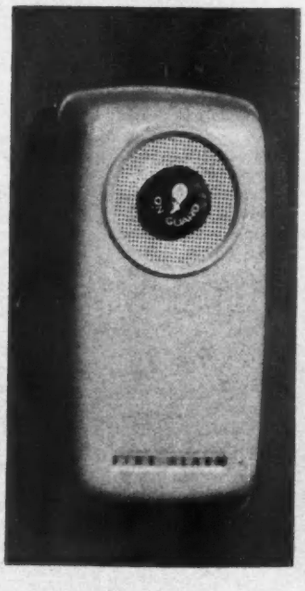
Up to five steel rings can be mounted on a tube to form the carriage of the machine and each ring can carry 48 bobbin cradles for the copper coated high tensile steel reinforcing wire. The cradles can be rotated to take out natural twist, and to insert artificial twist to grip the hose. The front of the carriage is mounted on support rollers allowing access for threading.

Each wire can be tensioned separately and up to 240 can be brought through the die plate to form a side-by-side spiral cover on the tube. Breakage of a wire will stop the machine. In operation the layers would be applied alternately handed. The take-off mechanism is one of the Carter puller units driven from the back shaft, through an infinitely variable gear to allow any pitch or lay to be obtained.

Wide variations are possible in the number of wires, their diameter and the angle of lay, and the range of hose diameters that can be handled is also large. *B. and F. Carter and Company Limited, Albion Works, Bolton.*

FIRE ALARM

Self-Contained



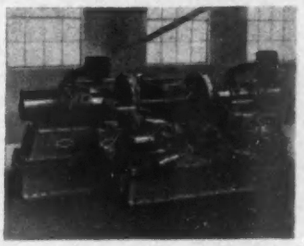
BATTERY powered, the Fire Cry-er alarm can be hung on the wall and is said to be clearly audible for 1,000 ft.

The unit is operated by a bimetal strip set to make contact at 135° to 140° F. Standard dry batteries are used and the recent leakproof types will last at least a year. A test switch is incorporated by which the operation can be checked at regular intervals. With new batteries the horn will sound continuously for an hour.

Resetting is automatic when the temperature falls below the set value and, being independent of the electricity mains or any other supply source, the unit can be used anywhere. It is advisable to mount it at some high point to detect the rise of hot air. Batteries are replaced by unscrewing the back. The casing measures 6 in by 3 in so very little space is needed. It is claimed that the "scream" of the horn will awaken the soundest sleeper. *Fire Cry-er Limited, Jack Bridge Mill, Colden, Hebden Bridge, Yorkshire.*

WHEEL LATHE

Independent Tools



A NEW wheel lathe will accommodate diesel and electric traction sets as well as wagon and carriage wheels.

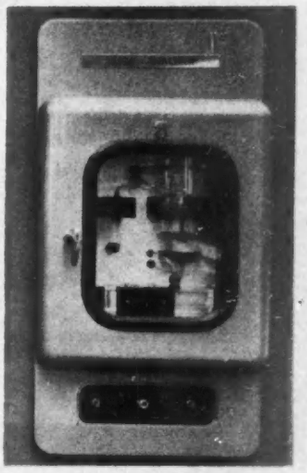
The wheel set is carried between revolving centres and the drive is by a pair of friction rollers to both wheels. The rollers are tapered and engage the wheel rims at an angle, each pair being mounted in independent and opposed sliding blocks which are hydraulically operated to provide a fully balanced self-contained thrust of sufficient pressure to transmit the driving torque. The saddles are separate but advance in unison, and are electrically tripped to maintain a correct relationship between the rollers and the tread.

The main drive is by a 48 h.p. two-to-one commutator motor through a three speed gearbox, giving an infinitely variable range of cutting speeds between 50 and 160 ft per minute. The hydraulic supply for the roller grip comes from a two pump unit; after the grip has been applied it is held by one pump only.

Electrically operated profile copying equipment on each tool rest is used so that both tyres can be machined simultaneously. The tool slides are set to the correct gauge and have transverse adjustment to accommodate various wheel diameters. Any gauge can be accommodated and wheel diameters can be from 30 to 48 in in one machine and from 36 to 60 in in another. Hand adjustment, power feed, and quick power traverse are provided in both longitudinal and transverse motions of the slides. Separate motors, which can be controlled by the tracer head, supply the power. *Craven Brothers (Manchester) Limited, Vauxhall Works, Reddish, Stockport.*

SILICA ANALYSER

for Feed Water



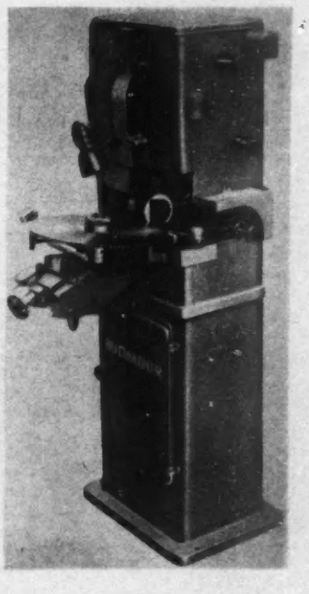
THE proportion of silica in boiler feed water can be continuously analysed by a sensitive colorimeter.

Silica carryover can become dangerous in high temperature steam plant as it will volatilise and deposit on turbine blades. In the instrument illustrated there are two proportioning cylinders, one feeding the sample and the other the reagent. The two are discharged in a timed sequence, stirred together for 5 minutes, then a reducing agent added and the mixture discharged into a measuring cuvette.

The colour of the resulting solution is then compared photoelectrically with either a standard Perspex blank or the original sample and the differential current fed to a transistor amplifier the output being used to drive a recorder. The whole sequence is entirely automatic, being controlled by a mechanical programme timer which allows adequate time for each operation. One complete cycle takes 12 minutes. There are three instruments in the series covering concentrations of 0 to 0·2, 0 to 2·5 and 0 to 30 parts per million. Operation is from standard mains supplies. *Electronic Instruments Limited, Richmond, Surrey.*

SAW GRINDER

Straight or Circular



ALL types of metal cutting saws can be ground on a Buchador machine now available in this country.

Circular metal cutting saws from 2 in to 16 in diameter can be handled and wood cutting saws up to 24 in. Band saws within the width range $\frac{3}{16}$ to $2\frac{1}{2}$ in can be accommodated. The blades can be up to $\frac{1}{16}$ in thick and side bevelling angle of scoring teeth may be 45° on each side Grinding is at the rate of 50 to 80 teeth per minute.

During grinding the blade is stationary and the wheel moves forward to grind the face of the tooth. The wheel then goes back and the saw blade is fed forward by a pawl mechanism and, while the wheel continues to return, the back of the blade is ground. The pitch of teeth of straight blades can be up to $1\frac{1}{16}$ in and of circular blades with side bevel teeth up to $\frac{13}{16}$ in. The maximum tooth depth is $\frac{13}{16}$ in. The machine can be supplied with or without the pedestal. *Addison Tool Company Limited, 28 Marshalsea Road, London, SE1.*

New Tape and Measuring Rod for Site Use

The tape and rod increase the accuracy of measurements taken at speed on awkward sites or in assembly shops. The tape is self-tensioning. Telescopic, the rod is designed so that one man can take measurements of 4 to 16 ft.

By D. Bishop, A.M.I.C.E., A.R.I.C.S., and J. H. Ripper, B.Sc.

Building Research Station, DSIR

Two new measuring devices have been developed at the Building Research Station as part of a study of techniques of measuring buildings and building components accurately and quickly; they will also be of value in fabricating and assembly shops concerned with large products.

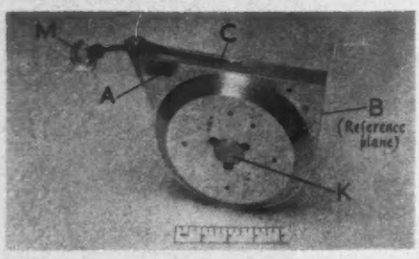


Fig. 1 Exterior of tape casing, showing window in the top of the case and the tape lock.

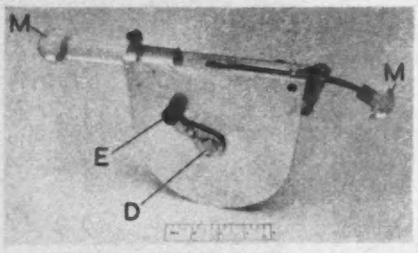


Fig. 2 Reverse of tape casing, showing rewind handle and end attachment for measuring into corners.

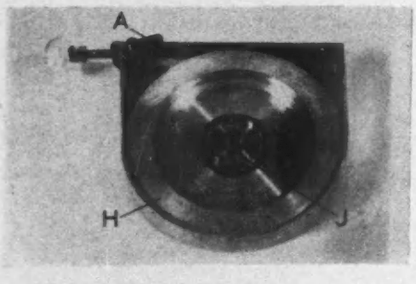


Fig. 3 Internal view of half of the case shown in Fig. 1, showing the tape lock, tape drum and dog clutch.

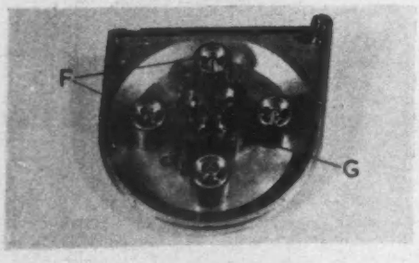


Fig. 4 Internal view of half case shown in Fig. 2 showing the spring mechanism.

Accurate measurement with conventional methods requires the time of a skilled observer. It also demands a high degree of care—frequently difficult to exercise in practice when many measurements must be made in awkward conditions—in order to eliminate errors arising from variable tensioning of the tape and from incorrect identification of the points to which measurements are to be made. This latter factor is of special importance when measurements are taken internally between planes or to corners bounded by two or three planes.

Ad hoc trials show that errors of measurement of up to $\frac{1}{4}$ in can arise from incorrect identification of the points to which measurement is made and that, at longer distances, errors in tensioning can account for an additional error of $\frac{1}{4}$ in. These trials were carried out under more or less ideal conditions, and errors that arise in practice may be appreciably larger. Such errors are particularly important as they are systematic and tend to over-estimate the distance measured.

To overcome these difficulties a tape has been developed which enables the longer measurements to be made rapidly by one observer with one unskilled assistant, and also a measuring rod to enable one unskilled observer to take accurate measurements for shorter lengths, up to 16 ft.

The Tape

The measuring tape (Figs. 1 to 4) differs from those normally used in that a fixed tension can be applied to it at any length, and it can be locked in position once the ends have been brought up to the measuring points. In this way the variations arising from errors in tensioning that occur unless a spring balance is employed are eliminated and the operations of bringing the tape to the point of measurement and of reading are separated. In any case, in practice, obstacles in the buildings frequently preclude the use of spring balances.

The tape is enclosed in a case which is provided with a tape lock (A), and it is so arranged that when dimensions are taken between planes, the tape case (B) provides a plane of reference, the correct reading appearing opposite the index mark in the window (C). The operation of measuring is straightforward; the tape is run out in the ordinary fashion to within a foot or so of the target, the clutch button (D) is depressed and the tape re-wind handle (E) is turned over the clutch button to hold it in position. At this stage the case is drawn up to the target under tension and the tape is locked in position. The reading may then be taken. The tape is released and reeled in, in the normal way.

The tension is provided by an assembly of four constant-tension springs, mounted freely on bobbins (F), with one end of each spring fixed to the central take-up bobbin (G) which is engaged to the tape drum (H) by means of a dog clutch (J) actuated by the clutch button. When the springs are released their energy is absorbed by a damping mechanism (K) contained in the take-up bobbin (G). The weight of the unit complete with a 100 ft steel tape $\frac{1}{2}$ in wide is about 3 lb 6 oz. The tape is being redesigned so that the mechanism is mounted on the tape drum rather than on the case. This relieves the case of the reaction from the damper and, thus simplified, it could be pressed out or turned.

This device enables accurate measurements to be taken in one-third to one-half of the time normally required when an ordinary tape is used with a spring balance, or in about the same time as that taken with an ordinary tape when a spring balance is not used. This combined speed and accuracy would be of value in setting out many types of civil engineering work or in setting out for the erection of large pieces of mechanical plant. Moreover, the ease of operation is of particular importance when the measurements are made under difficult conditions—setting out tunnels and jetties for example.

The Rod

The telescopic rod (Figs. 5 to 7) enables an unskilled operator to read dimensions in the range of 4 to 16 ft to an accuracy of 1/32 in. It is provided with calliper fittings (L) (Fig. 6) for taking external measurements and other fittings (M) for measurement into angles, and seems well suited for the rapid measurement, for example, of storey heights, distances between columns, size of window openings and the like. The rod weighs 2·2 lb and consists of five lengths of extruded aluminium alloy tube which nest together; when telescoped the rod is 4 ft long. The largest tube (N) acts as the casing; the second largest (O) is calibrated and the three other extensions (P) each add 3 ft to the length of the rod. Thus, the outer casing and the indicating section alone measure up to 7 ft; with one section extended, the device measures in the range 7 to 10 ft and so on.

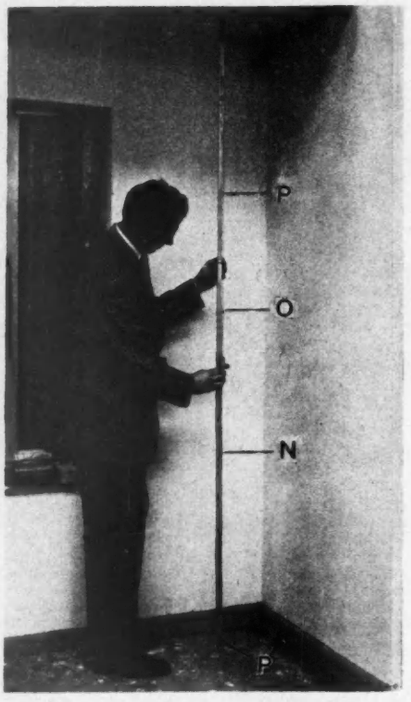
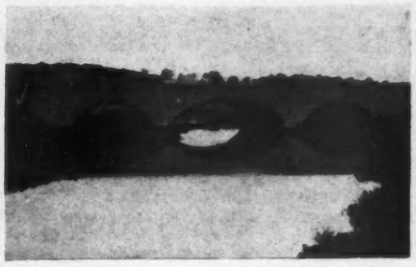


Fig. 5 Checking a storey height (7 to 10 ft range).

The fact that one person can take measurements up to 16 ft rapidly and accurately should make the rod attractive for surveying in many types of work. Its ability to measure accurately will be useful to all contractors who need to fit their work to the job as left by other trades.

Both the tape and measuring rod can be provided with sets of end attachments (shown at M, Fig. 6) so that accurate measurements can be taken into corners bounded by either two or

Warren Road bridge.



Welland River bridge.

Ingthorpe bridge.

Nine Mile Bypass Completed Around Stamford

On Monday, 31 October, 1960, the Minister of Transport, the Rt. Hon. Ernest Marples, M.P., officially opened the Stamford bypass and the reconstruction of the A1 from Carpenter's Lodge to Wansford, a major part of the Great North Road improvement programme that was carried through with A. Monk and Company Limited, of Padgate, Warrington, as the main contractors. The consulting engineers to the Ministry of Transport have been Stirling, Maynard and Partners of Peterborough, Major Stirling having been concerned with the preliminary plans for the work since 1937.

The bypass, which is constructed to motorway standards, starts at a new roundabout on the A1 at Carpenter's Lodge, two miles south of Stamford, and, running northwards, cuts well into the high ground on either side of the Welland Valley. These deep cuttings had to be formed partly to obtain the specified gradients and partly to provide the filling material for the embankment across the valley. An embankment had been preferred to a viaduct because of the poor stability of the subsoil would have meant excessive difficulties in piling. Construction of this section involved the excavation of some 1,100,000 cu. yd of material of which 400,000 cu. yd was oolitic limestone and ironstone. Where the embankment crosses the flood plain in the Welland valley, the banks are strengthened by pitching to prevent scour in time of flood.

COMPLETION ON TIME

Crossing the River Welland by a three-arch *in situ* reinforced concrete bridge, faced with Clipsham stone, the road continues northwards before it falls again to cross the River Gwash, over a similar three-arch bridge, near Tickencote, where it terminates in a second new roundabout. On 31 July, 1960, the contract was extended to include the reconstruction of a half-mile section of the A1 north of the Tickencote roundabout. This was necessary to eliminate a bottleneck between the end of the bypass and a three lane carriageway in Rutland; for reasons of safety completion had to coincide with that for the bypass. In addition to the Welland and Gwash rivers the bypass bridges the Welland Valley railway line, three major roads, two minor roads and three farm tracks. At all three major road bridges, connections are provided with the bypass by either loop or slip roads.

Work commenced on 22 June, 1959, and was scheduled for completion by 22 December, 1960, with one carriageway open to traffic by 22 September, 1960, but after taking into consideration the traffic problems that would be created by opening only one carriageway, it was decided that both should be opened together at the end of October, 1960.

Bulk excavation and construction of the bridges on the Stamford bypass was planned to commence during 1959 and to continue into early 1960, with carriageway construction following during the spring and summer of 1960. When bridge foundation work was under way it was found that the ground bearing capacity under five of the bridges was considerably less than the design requirement and the bridge foundations had to be redesigned, with a considerable increase in the volume of work, part of which included driving a total of 1,500 prestressed concrete piles. In consequence, the construction programme had to be accelerated to include the additional work and, to ensure completion of the revised bridges to the planned schedule, it became necessary greatly to increase the rate of progress during the winter months.

Similar carriageway construction was used throughout all sections and consisted of 10 in of granular sub-base, 8 in of lean mix concrete, 2½ in of gravel asphalt base course and 1½ in of granite asphalt wearing course. Construction of the lean mix concrete base on the Stamford bypass section was commenced only five months before opening, that is, at the end of May, 1960, and asphalt commenced during July. For much of the road a precast flush rippling kerb has been laid; this marker kerb has a serrated top with ½ in deep indentations 6 in wide and 6 in apart, and thereby gives an audible warning to the driver who is on the edge of the carriageway.

THREE BRIDGE TYPES

Work on the A1 reconstruction section was of a very different nature. Progress and planning were mainly dependent on arrangements for handling the large volume of traffic and for diverting existing services with a minimum of disruption and inconvenience. Work on this section first started on the lengths of new carriageway that were clear of the old road, thus enabling traffic to be diverted on to the new sections while the old road was removed.

Three of the bridges along the route are shown in the illustrations. Warren Road overbridge is a single span portal frame of 99 ft clear space designed to give an uninterrupted view across the valley. A three-span reinforced concrete arched bridge crosses the River Welland and also the River Gwash. Ingthorpe bridge, with a four span continuous deck of cellular construction, is typical of four of the principal bridges that have been built. The architectural advisers for the bridges have been F. J. Lenton and Partners of Stamford.

The bridges may be considered as three distinct architectural types, considerations of clearance and loadings permitting varied solutions in each case. For the river bridges over the Welland and the Gwash, little clearance was required and a traditional treatment of triple arches has been adopted. The concrete arch rings are allowed to show to the face, but both the spandrels and the soffits, as well as the cutwaters and the parapets, are faced with Clipsham stone.

In all, 14 bridges were constructed, more than 68,000 cu. yd of concrete placed, 43 miles of kerbing laid and 54,000 tons of asphalt used in the construction of this 9 miles of new road, which will bring much needed relief to the traffic congested centre of Stamford.

Concluding **New Tape and Measuring Rod**

three planes. These attachments consist of small hemispheres which, when placed in contact with the bounding planes, define notional corners, thus simplifying the measurement and reducing the error occasioned by minor irregularities of the actual corner. The actual measurement taken is, of course, corrected to allow for the length of the attachments and for the gap between the sphere and the corner.

It is hoped that these devices will be aids to accurate measurement and at the same time reduce the cost of setting out and of measurement by increasing the speed at which accurate measurements can be taken. Both the tape and the measuring rod are the subject of a patent application and have been passed to the National Research and Development Council for exploitation.

Acknowledgments.—The work with which this paper deals forms part of the programme of the Building Research Board and the paper appears by permission of the Director of Building Research. The authors acknowledge the assistance given by Mr. H. Spencer of the engineering workshops of the Station.

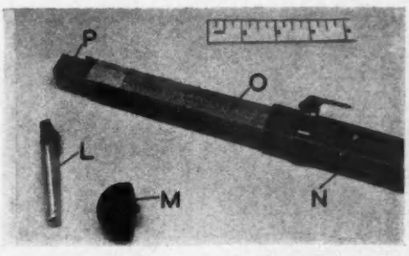


Fig. 6 Measuring rod and its end attachments.

Fig. 7 Measuring a room (10 to 13 ft range).

Plans and Demands in Air Conditioning

From air conditioning the offices of senior executives and crane operators to doing the same for computers and other delicate instruments, industry has plans for major spending in this field of equipment.

AIR conditioning equipment in industry, in offices and hotels and in transport is certain to be installed in an increasing number of cases over the next few years.

This is the opinion of engineering companies, whether subsidiaries of the big industrial empires or modest contracting works, who have contributed to an ENGINEERING survey of recent air conditioning equipment installation, future intentions and technical requirements.

A valuable summary of improvements that could usefully be made in present air conditioning plant came from Associated Electrical Industries Electronic Apparatus Division, Leicester.

There is scope, said the division, for:

> "Improved forms of filtration media requiring less maintenance and lower replacement costs.
>
> Cheaper forms of plenum ducting, particularly for those with acid and chemical resistance.
>
> Cheaper and better means of incoming air diffusion and better control of temperature."

The AEI Electronic Apparatus Division has spent £50,000 on air conditioning equipment for its works over the past five years and is anticipating spending another £20,000 in the near future.

STANDARD TEST URGED

From the Carborundum Company, who have put £23,000 into air conditioning at their Trafford Park works, Manchester, and have further plans for more installations, comes the suggestion that there should be more general use of self-cleaning primary air filters.

Many firms expressed satisfaction with the equipment they have used. The Appleby-Frodingham Steel Company makes the point that in the steel industry the equipment for air conditioning should be robust and generously rated to allow it to cater for fairly wide fluctuations in operating load.

The Ferranti Company would like to see "more reliable control equipment."

It also makes the proposal that all air filter makers should use the same efficiency tests—BSS 2831/1957. Ferranti are speaking from experience. In the last five years they have spent £58,000 on air conditioning equipment for their works. £16,180 is being spent this year on installations, and there are schemes to invest another £31,300 on installations in the future. All this, the company points out, is for full air conditioning and does not include plenum plants or clean air vent systems. The cost of providing suitable buildings has also been excluded from these costs.

Honeywell Controls Limited, of Greenford, Middlesex, having spent £8,000 on air conditioning the works prior to this year are putting in general air conditioning plant worth £5,000 in the course of 1960.

Mr. J. A. DePuy, a director, writes that he is sure the air cleaning and odour removing effects of air conditioning, although primarily applied to industrial processes today, will increase in offices, homes, stores, theatres and so on . . . "for economic reasons."

There is undoubtedly a cautious attitude abroad in parts of industry to the whole subject of air conditioning. Some firms wrote to say in effect—"apart from fume extraction, and ventilation when the heating is on, we don't need it."

A different type of caution was expressed by the Fairey Engineering Company, of Heaton Chapel, Stockport. The company is spending £28,000 this year on equipment for heating, ventilating and the extraction of graphite dust for its Nuclear Clean Conditions Assembly Department.

To ENGINEERING's question on suggestions and general observations, Fairey Engineering replied, "We would prefer to reserve comment until the equipment is in operation."

Some idea of the commitment of heavy engineering to air conditioning is given by the figure of £154,000 invested by C. A. Parsons, the Newcastle upon Tyne turbine manufacturers, during the past five years.

A world famous car manufacturer, remaining anonymous for this survey, makes no bones about saying that its plans to spend £15,000 on air conditioning equipment for a special building this year are specifically for computer equipment and for senior executives.

Many firms pointed out that they had elaborate, and effective ventillation systems, a field in which Colt and other British firms have distinguished reputations. But they were quite happy with these and were not yet thinking of putting in air conditioning plant.

The Howard Clayton-Wright group of engineering companies explained their special problem. The firm does not use standard air-conditioning equipment but has installed its own hot air drying plant and extraction equipment for the drying of thermoplastic granules.

"This plant and equipment," writes the technical director, Mr. R. R. Webb, "tends to introduce air-conditioning problems in the shop in which it is used and this has been dealt with by the use of steam heated units which replenish the shop with hot air on a thermostatically controlled basis."

AEC Limited, the vehicle builders of Southall, Middlesex, have spent £30,000 on air conditioning equipment of special application to the engine testing and paint spraying departments over the last five years. In the same period £4,000 has been expended on plant for use with data processing equipment and the telephone exchange.

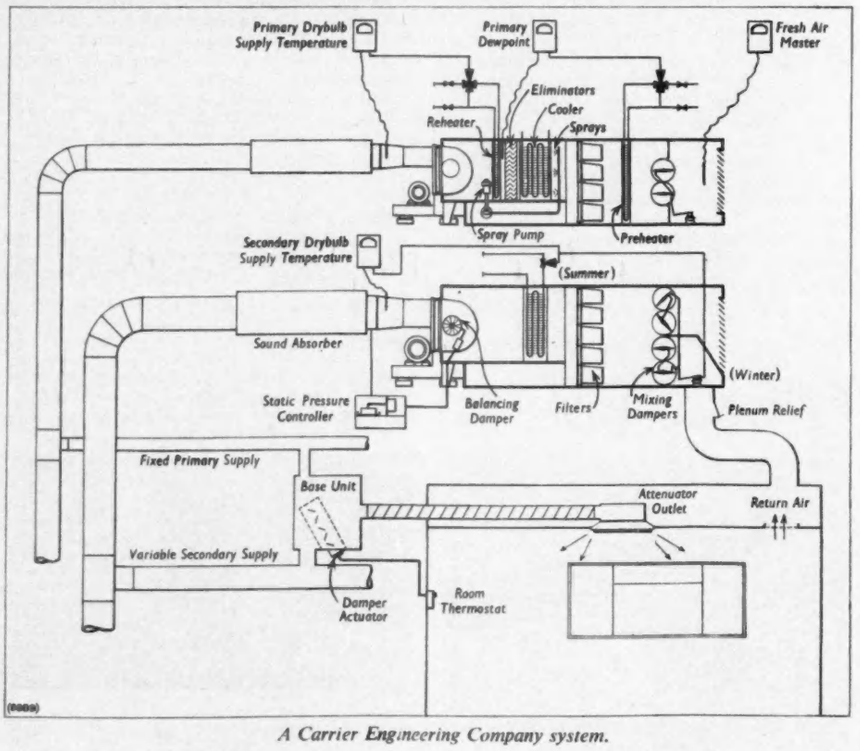
£15,000 is being spent on air conditioning equipment for the paint spraying department this year. Operating in ground floor premises in fairly open surroundings the company does not feel that for the work being done there is any necessity for general air conditioning.

There are other industrial concerns where there are special problems for which air conditioning must be called in and where general application either takes a secondary place or is not found at all. The Appleby-Frodingham Steel Company, of Scunthorpe, Lincolnshire, while spending much greater sums on ventilation, has a current scheme this year for putting in air conditioning equipment worth between £12,000 and £14,000. This will be 95 per cent for application to the special problem of hot crane cabins. The other five per cent is for general purposes such as in offices.

Within the period of the next five years it is tentatively expected that between another £50,000 and £60,000 will be spent. Since the expenditure on air conditioning equipment over the last five years by the company has been £7,000 for the works and £6,000 for offices there is an immense increase in the spending in this direction by one, important, unit in the steel industry.

Appleby-Frodingham, a subsidiary of the United Steel Companies, explain that air conditioning is becoming increasingly essential rather than just desirable in control cabins and similar places subject to high temperatures. The need for better all-round vision and greater speed and accuracy of operation of controls makes comfortable working conditions a necessity if the operator is to reach optimum efficiency.

The company's new installations are mainly for greater comfort and efficiency on existing plant. In all new processes and plant the question of air conditioning will receive careful consideration.



A Carrier Engineering Company system.

More University Reactors

CONCLUDING the report on university reactors, two further manufactures are briefly considered. Both are comparative newcomers to Britain and are seeking to enter into an already highly competitive atmosphere. Even when English universities do have their own reactors, which they eventually must no matter how long they have to wait, the numbers will certainly be very restricted. Of all the reactors now considered, only Consort is of entirely British design. But it is likely that the other reactors will have the majority of their components made in the United Kingdom.

AMF Reactors

Another research reactor maker who will soon be trying to make his way into the British university market is AMF Limited, the British associate of American Machine and Foundry Company. Last August a special division of AMF Limited was set up to handle nuclear affairs in Britain. They have two reactors to offer which are suitable for university requirements. The first is a low power 10 kW light-water graphite-moderated reactor, known as the "Educator." So far only three of these have been sold. The second is a pool-type reactor which may be rated up to 100 kW. The additional power gives obvious advantages which the majority of English universities would consider necessary if the reactor is to be used for research. Fifteen of this type have now been sold throughout the world. Table 3 gives the main parameters of both models.

Pool Reactor Features

The increase in power from 10 kW to 100 kW necessitates the addition of a small portable cooling unit and certain minor alterations to the control system. The basic installed equipment remains the same. The pool is of rectangular shape with aluminium lining, approximately 5 ft by 8 ft by 21½ ft high. This provides a vertical height of 17 ft of water above the core for shielding; the lower portion of the biological shield is made of barytes concrete and the upper portion of normal concrete, giving a radiation level outside the biological shield of less than 0·75 mr per hour for the 10 kW version (Fig. 7).

Fuel and Control Elements

The fuel elements are similar to those used by the USAEC, MTR and BSF reactors—each element contains twelve fuel plates. The control fuel rod elements have six fuel plates only, three on each side of the central guide channel through which the control rod enters. There are 35 holes in the rectangular lattice of the aluminium grid plate to receive the fuel elements, graphite reflector elements or test sample containers.

Experimental Facilities

Typical usable fluxes which may be expected at 10 kW on the pool reactor are given below in neutrons per sq. cm per second. Figures for the 100 kW must be multiplied by a factor of 10.

Maximum thermal flux: 3×10^{11}
Thermal column, inner face: 1×10^{11}
Thermal column, one foot inside outer face: 1×10^{8}
Isotope production facility: 1×10^{11}

On the standard 10 kW version the experimental facilities include two 6 in horizontal beam

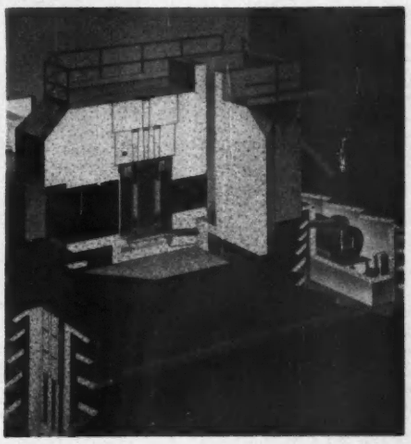


Fig. 4 Sectional view of the University Teaching and Research Reactor (UTR). Fuel storage pits are shown in the bottom left hand corner. For UTR-100 the required height space is 22 ft.

tubes from the core face; bulk shielding facility in a pool 5 ft by 8 ft; pneumatic rabbit system; thermal column (4 ft by 4 ft) with many stringers, encased in an aluminium chamber, which is covered by an approximately 5 ft square barytes concrete door removed on rollers; and seven 1 in aluminium tubes which extend vertically from the top of the pool into the thermal column. The irradiation facilities on the Educator are very similar.

UTR Reactor

Although the University Teaching and Research reactor range was mentioned in last week's issue, further details are given below. This reactor, which has been developed at the Advanced Technology Laboratories division of American Standard, California, is another offspring from the "Argonaut" concept, using the water-moderated graphite-reflected system. The core is standardised throughout the three versions and it is possible to convert to another power level if required at a later date after purchasing. There are several UTR's in operation in the United States and one under construction for the Australian Atomic Energy Commission at Lucas Heights, Australia.

Three Variations

The UTR-B operates at 10 watts (thermal power) and at a maximum thermal flux of 10^9 neutrons per sq. cm per second. The shield may be a cylindrical tank containing sand and water, monolithic concrete, or stacked concrete blocks.

The URT-10 is a 10 kW reactor giving 10^{11} neutrons per sq. cm per second thermal flux at the central stringer. Monolithic concrete shielding is used on this version.

The UTR-100 is a 100 kW version and is the most suitable for universities. It produces a flux of 10^{12} neutrons per sq. cm per second at the central stringer which is sufficiently high for irradiation experiments. A startup heater is included in the system to raise the water temperature to 100° F (37·8° C) to minimise the required excess reactivity.

The fuel loading is standardised in comparison with Jason and is located in two rectangular tanks as shown in Figure 4.

UTR-100 Experimental Facilities

Standard equipment consists of two 6 in beam ports, one on each side of the reactor face; five graphite stringers in the high flux internal reflector region; shield experiment tank, 7 ft by 8½ ft by 12½ ft deep, connected by a graphite duct 2½ ft square by 3 ft 5½ in long in the reactor face; thermal column 4 ft by 5 ft by 5 ft containing 15 horizontal stringers accessible by a rail mounted door. As usual throughout most of the reactor systems discussed, access to certain stringers may be made through a port or plug in the shield closure. Additional items available are a radioisotope production facility, comprising a cylindrical graphite block in the central core region containing a ring of 12 slots for insertion of samples and a pneumatic tube; through tubes 2 in square; and an irradiation

TABLE 3:—*Main Parameters of the AMF and UTR Reactors*

	AMF		UTR		
	Educator	Pool	B	10	100
Thermal Power	10 kW	10 kW to 100 kW	10 W	10 kW	100 kW
Fuel	Uranium-alumium alloy		Uranium aluminium alloy		
Uranium 235 enrichment	20 per cent	90 per cent	20 to 90 per cent		
Approximate critical mass (gm)	4,000	2,380	3,300		
Coolant	Water		Water		
Moderator	Graphite and water	Water	Water		
Reflector	Graphite	Graphite and water	Graphite		
Fuel cladding	Aluminium	Aluminium	Aluminium		
Shielding	Concrete	Water, lead and concrete	Water and sand,	Concrete	Concrete
Control	Four swinging arm type cadmium blades on individual drives (reactivity worth greater than 1 per cent for each rod), and dumping of the moderator	2 Boron Carbide shim safety rods in cadmium lined aluminium sheath. 1 Stainless Steel regulating rod (0·4 to 0·6 per cent reactivity worth).	4 Boron plate control elements		
Coolant rate (gallons per minute)	10	Natural convection (Pump required on 100 kW Version)	4	10	50
Central flux (neutrons per sq. cm per second)	10^{11}	3×10^{11} at 10 kW, 3×10^{12} at 10 kW	10^{9}	10^{11}	10^{12}
Source strength	10 curies	7 curies			

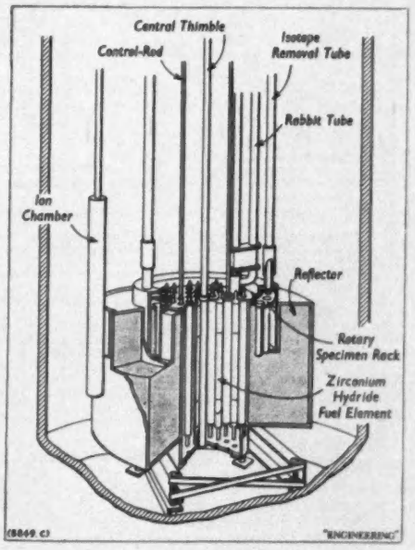


Fig. 5 Core and reflector assembly of the Triga Mark II. Beam tubes Thermal column are not shown.

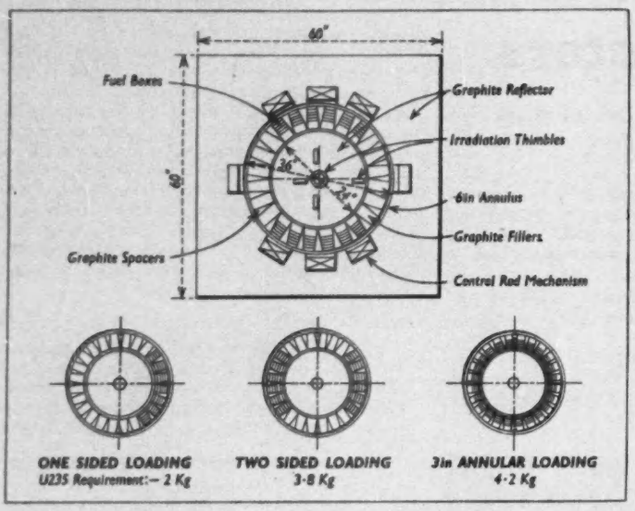


Fig. 6 (above) Plan view of the Jason core assembly and the pattern of the various core loadings possible showing the different critical masses required.

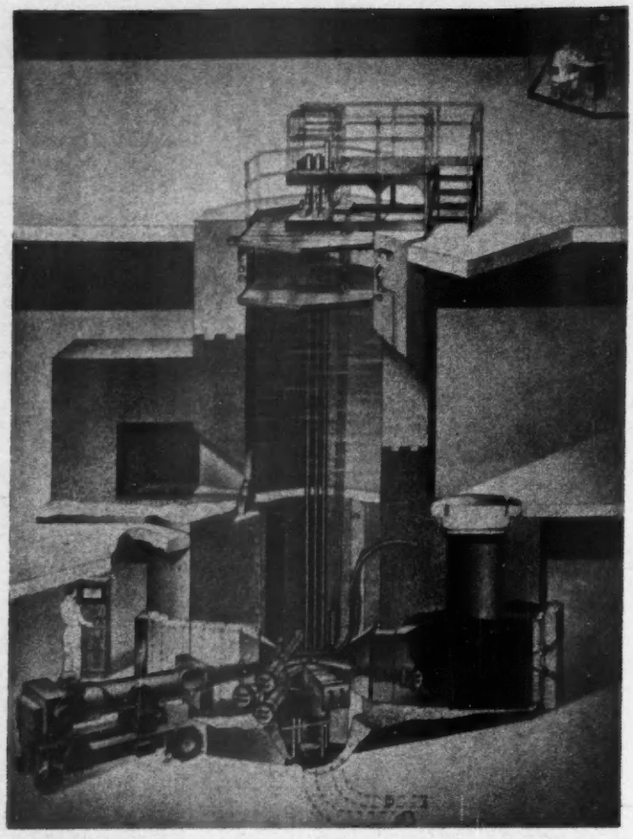


Fig. 7 (right) Sectional view of the American Machine and Foundry (AMF) Pool Recator showing the distribution of radiation facilities.

cavity 2 ft by 2 ft by 2 ft over the thermal column, made accessible by a removable concrete lid over the cavity. These facilities are also available for the 10 kW version and in a much reduced number for the "Basic" version.

Customer Requirements

The above considerations of each reactor design show that there is strictly no limit to the number of irradiation facilities, and it is usual to build a reactor to the requirements of each customer. The fuel for the Triga reactor is always supplied with it but in the case of Jason and Consort the customer is encouraged to try and hire the fuel from America since the American charge is considerably less than that of the UKAEA. AMF Limited state that either American or British fuel may be used in their range.

Staffing

The staff required to run a small research reactor may comprise six to seven people. The director and his assistant must be fully qualified to operate the reactor and will have undertaken a preliminary approved training course on reactor operation. In addition, four or five technicians will be required to assist in operation of experiments or at least be familiar with the reactor and its facilities in order to "bridge the gap" in the event of illness for example. There must also be a qualified health physicist on the site to keep a careful check on radiation levels.

TABLE 4:—*Typical Experiments that may be conducted on a University Reactor. (Taken from General Atomics' literature available for Triga II.)*

I. REACTOR OPERATION AND PERFORMANCE
1. Radiological Safety Survey: Effects of a Beam Catcher.
2. Time Response of Reactor Safety Systems.
3. Operation of the Reactor.
4. Control-rod and Power Calibration.
5. Temperature Coefficient of the Reactor.
6. Reactor Kinetics.

II. REACTOR PHYSICS
7. Determination of Neutron Flux Distribution by Foil Activation.
8. Fast Neutron and Gamma-ray Shielding.
9. Gamma-ray Intensity in the Core.
10. Fission Properties of Uranium 235.
11. The Kinetic Energy of Fission Fragments.
12. Delayed Neutron Emission in Uraniuam 235 Thermal-Neutron Fission.
13. Diffusion Length and Transport Cross Section of Thermal Neutrons.
14. Measurement of the Neutron Age in Graphite.
15. Albedos of Water and Paraffin for Thermal Neutrons.
16. The Importance Function.

III. NUCLEAR PHYSICS
17. Neutron Absorption Cross Section by Danger Coefficient Method.
18. Self-shielding and Absorber Interaction.
19. Neutron Absorption Cross Sections with a Pile Oscillator.
20. Measurement of Thermal Neutron Cross Sections.
21. Resonance Activation Integral.
22. Neutron Crystal Spectrometer.
23. Neutron Energy Distribution in a Thermal Beam.
24. Nuclear Absorption of Neutrons.
25. Neutron Diffraction Structure Analysis.
26. The Slow Chopper.
27. Total Neutron Cross Sections.
28. Production of Short-lived Activities for Physics and Chemistry Research.

IV. SOLID STATE PHYSICS
29. Radiation Effects in Semiconductors.
30. Radiation Damage in Metals.

V. NUCLEAR CHEMISTRY
31. Determination of Fission-product Yields in the Thermal Fission of Uranium 235.
32. Szilard-Chalmers Process with Ethyl Iodide and Permanganate.
33. Neutron Activation Analysis of Gold (Trace Quantities).
34. Ion-exchange Separation of Cobalt 60 and Copper 64.

Research Main Aim

The General Atomic Division have published considerable literature of some experiments feasible for university use, and a list is given in Table 4 of a few that are possible for example on the Triga Mark 2. It may be assumed that it is possible to conduct similar experiments on the other reactor models considered in this article for the same power rating. Also it should be emphasised that the experiments in Table 4 by no means exhausts the number of experiments possible. Although one purpose of installing a reactor at a university is the education of first degree students, this is not generally considered the main object. The first aim is normally pure research for higher degree students. In this way some decentralisation of research from Authority and commercial establishments would be achieved. The presence of a reactor on a university site may encourage faculties other than engineering to employ the irradiation facilities. It is a strong argument for putting the reactor actually on the university site. This policy has been adopted as often as possible in America, since it encourages the participation of other faculties.

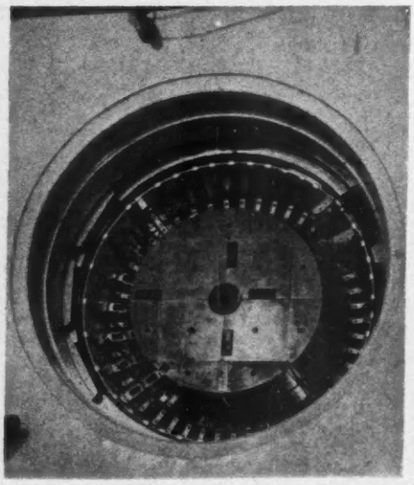


Fig. 8 View into the top of the Jason core showing the annular loading and the internal graphite reflector with the vertical and four eccentric beam holes.

Why Not Simulators?

It has been suggested that reactor simulators would be better for educational purposes, and would exclude any chance of radiation hazard. A simulator cannot, however, provide the research facilities that have been described as the main value of a research reactor. Although a simulator may demonstrate the manner in which change in power level affects control-rod movement, and the effect of various trips, temperature coefficient and xenon poisoning, the cost for these extra variants is considerable and also qualified personnel are required to operate it.

Ministry Approval

All the university reactors in the United Kingdom will be governed by licences issued by the Ministry of Power. The Ministry will inspect all the proposed sites to ensure that no harm can come to the surrounding community. It will also approve the design and safety requirements and probably initially limit the power level. Any alterations in the arrangement of the core may also be subject to control.

NEW ZEALAND
MINISTRY OF WORKS

The New Zealand Government Ministry of Works invites applications for Permanent Staff appointments. Positions available are:

CIVIL ENGINEERS
Qualifications—Corporate membership of the Institute of Civil Engineers, London: Commencing salaries from £985-£1700 per annum.

ASSISTANT CIVIL ENGINEERS
Qualifications—A University Degree in Civil Engineering which gives exemption from Final Parts I and II of the A.M.I.C.E. examination; or other qualifications exempting from Parts I and II of A.M.I.C.E. plus at least 5 years' appropriate experience. Commencing salaries from £900-£1120 per annum.

MECHANICAL AND ELECTRICAL ENGINEERS (AND ASSISTANTS)
Qualifications—Corporate membership of the Institutions of Mechanical or Electrical Engineers, London, or for Assistants a University Degree in Mechanical or Electrical Engineering or Graduate Membership of the above Institutions—Commencing salaries for Engineers £985-£1700 and for Assistants up to £1120 per annum.

BUILDING SERVICES ENGINEERS (AND ASSISTANTS)
Qualifications—Corporate membership of the Institution of Mechanical Engineers or of the Institution of Heating and Ventilating Engineers, London, or for Assistants, a University Degree in Mechanical Engineering or Graduate membership of the above Institutions. Commencing salaries for Engineers, depending on experience, £985-£1700 and for Assistants up to £1120 per annum.

DRAUGHTSMEN—CIVIL AND STRUCTURAL
Qualifications—Ordinary or Higher National Certificates or the final examination of the City and Guilds, London, or Associate Membership of the Institution of Structural Engineers are desirable but primary requirement is for skilled and speedy draughtsmen with substantial experience at the drawing board and in the types of civil engineering work designed by the Ministry of Works. Commencing salary up to £1120 per annum.

DRAUGHTSMEN—MECHANICAL, ELECTRICAL AND BUILDING SERVICES
Qualifications—Ordinary or Higher National Certificate in Mechanical or Electrical Engineering or equivalent examination, and at least 3 years' experience in draughting, design and calculations. Commencing salaries up to £1120 per annum.

QUANTITY SURVEYORS AND ASSISTANT QUANTITY SURVEYORS
Qualifications—Quantity Surveyors must be Associates of the Royal Institute of Chartered Surveyors or the Quantity Surveyors' Institute. Assistant Quantity Surveyors should have passed the intermediate sections of those examinations.
For both positions experience is required in the measuring and pricing of the building and allied trades, in final accounts and adjustment of contracts.
Commencing salaries up to £1400 for Quantity Surveyors and up to £1120 for Assistants.

Subject to completion of a Bond to remain in the service for 3 years, successful applicants will be assisted with expenses incurred in travelling to New Zealand. A superannuation scheme is available and there are generous annual and sick leave privileges.
Enquiries mentioning this publication, quoting reference number B11/30/23 and indicating the position sought, should be addressed to The High Commissioner for New Zealand, 415 Strand, London, W.C.2. Full details of housing available, fares payable, career prospects, type of work, terms of contract, local conditions and application forms will then be supplied.

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GENERAL FACTORY MANAGER

Applications are invited by BRYANT & MAY LIMITED for a GENERAL FACTORY MANAGER to take charge of a group of factories overseas.

Initially the successful candidate will receive training in the United Kingdom and be given every opportunity to familiarise himself with the industry. Within a reasonably short time he will be expected to assume full responsibility to the Board overseas for the operation of the factories.

Commencing salary range £3000-£4000. Candidates, preferably aged 40-50, must offer a successful record of senior management experience in the light engineering industry. Previous experience in charge of a group of factories essential. A University degree and a professional qualification in mechanical engineering are desirable and some knowledge of industrial chemistry would be an advantage.

Applications containing brief details should be addressed to the

PERSONNEL MANAGER (WORKS),
BRYANT & MAY LIMITED,
FAIRFIELD ROAD,
BOW, LONDON, E.3.

quoting Ref. No. 160.

D 303

REPRESENTATIVE
(Engineering Products)
LONDON AREA

for a long-established medium-sized expanding Company manufacturing a wide variety of drive and conveyor beltings. This appointment carries a basic starting salary of £1250, plus a bonus up to £150. The bonus earned annually is consolidated in the following year's basic salary. Other benefits include a company car, pension scheme and some allowances. Removal expenses will be met.

The Representative will cover an area of London and the Home Counties north of the Thames, containing existing accounts and very considerable sales potential. Substantial technical and advertising support is available to those in the field. The Representative will have some discretion to adjust catalogue prices. Training in Company products will be given.

Desired qualifications include a proven ability to sell engineering products to the engineering industry, together with mechanical and mathematical aptitudes.

Please write briefly in first instance quoting Reference No. 858, *to:—*

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

D 323

'Engineering' Appointments Section

ADMIRALTY—NAVY WORKS DEPT.

ELECTRICAL & MECHANICAL ENGINEERING DRAUGHTSMEN

Vacancies exist in Navy Works Department Drawing Offices as shown below and occur at Establishments elsewhere in United Kingdom from time to time.

The posts are non-pensionable but there will be opportunities for transfer to the Established staff.

Applicants must be competent Draughtsmen and experienced in one or more of the following types of work:—

Electrical (vacancies at Pinner (Middx.), Portland and Devonport).
(*a*) Preparation of specifications, drawings and schedules for electrical equipment. Précis of firms' tenders.
(*b*) Electrical installations in domestic and industrial buildings.
(*c*) Cable installations, switchgear, etc.
(*d*) Airfield lighting.

Mechanical (vacancies at Pinner (Middx.), Portsmouth, Portland, Liverpool, Rosyth, London).
(*a*) Preparation of specifications, drawings, schedules and précis of firms' tenders.
(*b*) District heating, including boiler installations, heating and air conditioning of domestic and specialist buildings.
(*c*) Layouts of engineering installations and workshop machinery.
(*d*) All classes of lifting appliances, pumping installations, test plants, cooking equipment, etc.

Possession of O.N.C. or similar qualification will be an advantage. Consideration will be given to successful candidates being granted assistance to obtain technical qualifications.

Salary (Men): National Rate—subject to slight variation dependent on location: starting from £580 (at age 21) to £870 (28 and over): maximum of scale—£955 p.a. (National Rate).

Opportunities occur for promotion to Leading grade—salary maximum £1115 p.a. (National Rate).

Five-day week: annual leave 18 days rising to 22 after 10 years.

Candidates, who must be British subjects, are invited to apply in writing, giving details of qualifications and experience to Director General, Navy Works, Admiralty, Chamberlain Way, Pinner, Middlesex.

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ADMINISTRATIVE COUNTY OF LEICESTER
APPOINTMENT OF SENIOR BRIDGE ENGINEER

Applications are invited from suitably qualified engineers for the above appointment in Salary Scale "A" (£1410 rising to a maximum of £1565 per annum). Starting salary dependent on qualifications and experience, which need not necessarily have been in the service of a local authority. An essential user car allowance on the County Scale will be paid.

Forms of application obtainable from the COUNTY ENGINEER AND SURVEYOR, COUNTY OFFICES, GREY FRIARS, LEICESTER. CLOSING DATE, 17th NOVEMBER, 1960.

JOHN A. CHATTERTON,
CLERK OF THE COUNTY COUNCIL.
GREY FRIARS,
LEICESTER.

D 294

UNITED KINGDOM TECHNICAL ASSISTANCE

Applications are invited for appointments as PROFESSORS in (1) NUCLEAR PHYSICS, (2) PHYSICAL CHEMISTRY, (3) ANALYTICAL CHEMISTRY and (4) HYDRAULIC ENGINEERING at the UNIVERSITY OF PESHAWAR, PAKISTAN. Applicants should have for (1) Doctorate, (2) and (3) Ph.D. in appropriate field, (4) a good degree. Teaching experience is also necessary. Salaries for all posts £2600-£3600 according to qualifications and experience, plus generous tax free allowances, all emoluments paid by U.K. Government. For further information and application form write to MINISTRY OF LABOUR (E9), 26/28 KING STREET, LONDON, S.W.1.

D 309

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW
DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited from suitably qualified engineers for the following appointments:—

SENIOR LECTURER

With specialised experience in high voltage engineering.

TWO LECTURERS.

To undertake teaching and research in electrical technology.

The Department has a large and expanding research interest, and a steady growth in the numbers of undergraduate students. Additional staff are required for lecture courses on a variety of special topics, and for the supervising of research in these fields.

Salary scales—Senior Lecturer, £1975 by £75 to £2275.
Lecturer, £1050 by £50 to £1400 by £75 to £1850.
with initial placing according to qualifications and experience. Form of application may be obtained from the SECRETARY, GEORGE STREET, C.1.

D 297

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD
EXPANSION OF BUILDING PROGRAMME

PRINCIPAL ASSISTANT ENGINEER—SCALE II required in Regional Engineer's Department. The candidate appointed will be in charge of a team responsible for a major division of the work of the Department, covering the design of Mechanical, Heating and Ventilating and Electrical Services for new hospitals, extensions, etc. It is essential, therefore, that those applying for this post should have had considerable experience in the design of service installations in large buildings, the control of design staff and the implementation of Contracts on site. The successful candidate will also be expected to prepare briefs for Consulting Engineers appointed by the Board to undertake the design of certain of their works; also advising Consulting Engineers during all stages of the implementation of the Engineering Works.

Applicants for the posts should be Corporate Members of the Institution of Mechanical Engineers and/or Institution of Electrical Engineers. Salary scale £1665-£3035 p.a., plus London Weighting £50. Superannuable.

APPLY, stating age, qualifications (with dates) and experience, with names and addresses of two referees to the SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 40, EASTBOURNE TERRACE, LONDON W.2, quoting reference NO. 857, by 14th NOVEMBER.

D 284

RHODESIA RAILWAYS
VACANCIES FOR SIGNAL AND COMMUNICATIONS TECHNICIANS

Applications are invited to fill vacancies in Rhodesia for Signal and Communications Technicians who are qualified in performing both signalling and telecommunications work, also applicants qualified to perform either mechanical or electrical work.

Single men between 25 and 35 years of age preferred, but married men within this age limit will be accepted provided they are prepared to travel to Rhodesia alone in the first instance.

Salary scale, 62s. 6d. to 68s. per day.

Free passage, pension, good service conditions, including annual leave with pay, sick pay and good prospects of advancement.

Applications in writing should be addressed to:—
THE LONDON AGENT,
RHODESIA RAILWAYS,
241, SALISBURY HOUSE,
LONDON WALL, LONDON, E.C.2.

D 286

COMMISSIONING
AND
OPERATION
OF
NUCLEAR POWER STATIONS

A number of responsible new appointments have been created in a team engaged on the commissioning and early operation of Nuclear Power Stations.

Candidates should be either Associate Members of a major professional institution or hold qualifications leading to Associate Membership. Some experience in the operation of conventional plant would be desirable. Full training in the operation of Nuclear Power Stations will be arranged for the successful candidates.

Please write Box Number
EG 1046 LPE, ROMANO HOUSE,
399/401 STRAND,
LONDON, W.C.2.

D 289

APC
NUCLEAR SAFETY

A vacancy on the permanent staff exists for a MECHANICAL OR ELECTRICAL ENGINEER as an assistant to the engineer in charge of the REACTOR SAFETY SECTION of the COMPANY'S SAFETY DEPARTMENT. He will be concerned mainly with the assessment of nuclear power plant designs from the safety aspect with the preparation of reports relating to these assessments.

Candidates should be between 25 and 30 years of age and should have a first or second class honours degree together with some works experience. An aptitude for analytical work and some knowledge of reactor technology are essential; previous experience in the design or operation of power plant, is desirable. The successful candidate must be prepared to tackle an extensive range of problems but will have an exceptional opportunity to obtain wide experience of nuclear power plant design.

Applications, giving full details of age, qualifications and experience should be sent to:—

The Personnel Officer,
(Ref. E/141),
Atomic Power Constructions Limited,
P.O. Box 90,
28 Theobalds Road,
London, W.C.1

D 306

THE UNITED STEEL COMPANIES LTD

WORKINGTON IRON & STEEL COMPANY

Branch of The United Steel Companies Limited

DESIGN ENGINEER

Applications are invited for the senior position of Design Engineer in the Engineering Division, who will be directly responsible to the Chief Engineer for direction and supervision of engineering design. The design work will be concerned with blast furnace plant, ore preparation, steelmaking plant, rolling mills, coke ovens and ancillary services including gas, steam and water. He will lead a design staff of engineers, technicians and draughtsmen.

Sound experience of design in relation to large capital development projects, not necessarily within the iron and steel industry, is essential.

The salary is substantial. The Company has a compulsory pension and life assurance scheme and offers a house or arrangements for assisted house purchase.

Apply in full (in strict confidence) without delay to:—

THE SECRETARY,
WORKINGTON IRON & STEEL CO.,
P.O. BOX NO. 5,
MOSS BAY, WORKINGTON,
CUMBERLAND

Endorse envelopes "Personal" and quote reference DE. D 251

Applications are invited for

SENIOR AND INTERMEDIATE DRAUGHTSMEN
IN ENGINEERING DEPARTMENT

Experience in the air conditioning and refrigeration field desirable. Interesting and important development work in connection with package and portable air conditioning apparatus.

Write, giving full details of past experience and qualifications, to:

THE SECRETARY, TEMPAIR LTD.
Victoria Works, Maidstone, Kent

D 328

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF WORKS
NORTHERN TERRITORY
PAPUA AND NEW GUINEA

ARCHITECTS
QUANTITY SURVEYORS
ENGINEERS
Civil—Mechanical—Structural—Hydraulic ENGINEERS

are required for DESIGN or CONSTRUCTION work in the tropical areas of the NORTHERN TERRITORY and PAPUA and NEW GUINEA at DARWIN, PORT MORESBY, LAE and RABAUL.

ARCHITECTS should be members of the Royal Institute of British Architects or hold the diploma of a recognised School of Architecture.
ENGINEERS should be members of the appropriate British institution or hold a University degree in Engineering.
QUANTITY SURVEYORS should be members of the Royal Institution of Chartered Surveyors or the Institute of Quantity Surveyors.

VACANCIES: NORTHERN TERRITORY
ARCHITECTS: Grade 3, two; Grade 2, two.
CIVIL ENGINEERS: Grade 3, two; Grade 2, two.
STRUCTURAL: Grade 3, one.
MECHANICAL: Grade 3, one.
HYDRAULIC: Grade 3, one; grade 2, one.

PAPUA—NEW GUINEA
ARCHITECTS: Grade 3, two, Grade 2, one.
QUANTITY SURVEYORS: Grade 2 two.
CIVIL ENGINEERS: Grade 3, one; Grade 2, one; Grade 1, one.
STRUCTURAL: Grade 3, two.
HYDRAULIC: Grade 3, one; Grade 2, one.

SALARY RANGES:
Grade 1, £1290, 8 annual increments of £55 to £1730.
Grade 2, £1730, 2 annual increments of £55 to £1840.
Grade 3, £1840, 3 annual increments of £55 and 1 at £65 to £2070.

DISTRICT ALLOWANCE: (in addition to the above): Married, £275 per annum; Single, £175 per annum.
ATTRACTION ALLOWANCE: Papua New Guinea **ONLY.** £75 p.a. for married men and further £50 p.a. (both married and single) subject to completion of 2 years' service.
INCOME TAX: is payable but at rates below those paid elsewhere in Australia.
LEAVE: Ten weeks recreation leave every two years with return air fares (at concession rates) to Sydney from Papua New Guinea and from Darwin to any capital city of the Commonwealth.
ACCOMMODATION: Furnished modern tropical houses available married men—rental 10 per cent of minimum salary (excluding allowances)—furniture rental 10 per cent of capital value. Full board available single men in hostels at moderate tariff.
FARES: Will be provided for successful applicants and dependants, subject to the applicant completing an appropriate Bond of Service. Salary will be paid from date of embarkation.

APPLICATION FORMS and further particulars from:—

OFFICIAL SECRETARY, AUSTRALIA HOUSE, STRAND, LONDON, W.C.2.

quoting ref. 60/6019.
Applications close on 15th DECEMBER, 1960. D 319

BIRMINGHAM REGIONAL HOSPITAL BOARD
ENGINEERING ASSISTANTS

Salary £600-1070 per annum. Interesting work in Regional Engineer's Department on design and installation of mechanical and electrical services for new hospitals and alterations to existing. Previous hospital experience desirable but not essential.—Apply (quoting Eng. 11) naming three referees to SECRETARY, 10 AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15 (from whom further details can be obtained) by 10th DECEMBER, 1960. D 327

CITY OF LEICESTER
EDUCATION COMMITTEE
LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

PRINCIPAL: R. E. WOOD, M.Sc., F.Inst.P

Applications are invited for the post of LECTURER in PRODUCTION ENGINEERING. Candidates should be well qualified, with appropriate experience, and able to teach Production Engineering subjects to a high level. Salary, Burnham Scale, £1370 to £1550 per annum, with increments for approved experience.

Further particulars and forms of application may be obtained from the REGISTRAR, LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE. D 326

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

CLERK OF WORKS (ENGINEERING) required for supervision of site works in various establishments.

Applicants must have served an apprenticeship in mechanical or electrical engineering and have had not less than five years' experience supervising site installations. They must be capable of supervising both mechanical and electrical work.

Salary scale, £800 by 40 (5) by 50 (1)-£1050, plus £30-£50 London Weighting. Superannuable, Whitley Council conditions.

APPLY, stating age, qualifications and experience, with names and addresses of two referees (preferably employers) to SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 40 EASTBOURNE TERRACE, W.2, quoting reference 859 by 16th NOVEMBER. D 332

CITY OF BIRMINGHAM
EDUCATION COMMITTEE
ASTON TECHNICAL COLLEGE

Whitehead Road, Birmingham, 6.

PRINCIPAL: D. DUDGEON STOCKLEY, B.Sc., M.I.Mech.E.

Applications are invited for the following posts in the Department of Mechanical and Production Engineering: (i) LECTURER, to teach production engineering subjects up to Higher National Certificate and Diploma level. Degree or equivalent desirable, together with suitable industrial and teaching experience. Salary, £1370 × £35 to £1550. (ii) ASSISTANT, GRADE B, to teach mechanical and possibly some production engineering subjects associated with C. & G.L.I. and National Certificate and Diploma Courses. Appropriate qualifications and practical experience essential. Salary, £700 × £27 10s. to £1150 with appropriate increments for degree, training, industrial experience and teaching experience.

Further particulars and an application form obtainable from the Principal, to whom applications should be returned within FOURTEEN DAYS of the appearance of this advertisement.

E. L. RUSSELL,
CHIEF EDUCATION OFFICER. D 329

LANCHESTER COLLEGE OF TECHNOLOGY, COVENTRY

PRINCIPAL: A. J. RICHMOND, B.Sc. (Eng.), Ph.D., M.I.Mech.E.

Applications are invited for the post of:

SENIOR LECTURER IN AIRCRAFT STRUCTURES

Duties to commence from a date to be arranged. Salary £1550 by £50 to £1750 per annum. In certain circumstances a successful candidate may be paid a commencing salary above the minimum of the scale.

The Department is now partially accommodated in new buildings and completely new and well-equipped laboratories are planned to come into operation by 1963. The person now to be appointed will have a substantial responsibility for equipment in the Aircraft Structure side of the Department including the development of research. The Department already offers a sandwich course in Aeronautical Engineering in addition to various part-time courses. Considerable development in relation to new courses is anticipated within the next year

Further particulars and application forms obtainable from REGISTRAR, LANCHESTER COLLEGE OF TECHNOLOGY, PRIORY STREET, COVENTRY, to whom completed forms should be returned by 30th NOVEMBER.

W. L. CHINN,
DIRECTOR OF EDUCATION. D 330

SURREY EDUCATION COMMITTEE

BROOKLANDS COUNTY TECHNICAL COLLEGE

HEATH ROAD, WEYBRIDGE

Required in Department of ENGINEERING, teachers of:—

(*a*) TECHNICAL MATHEMATICS to Ordinary and Higher National Engineering students with Engineering Degree or high academic qualifications and experience in teaching mathematics.
(*b*) ELECTRICAL ENGINEERING in subjects to O.N.C. standard initially and to assist with C & G courses, with degree in Electrical Engineering or equivalent; experience in teaching Electronics or Aircraft industry additional recommendations.
(*c*) MACHINE SHOP ENGINEERING for C & G courses. Intermediate and Final Year and allied Trade Courses.

Salary, Burnham Technical Scale, Grade B.
Application form from the PRINCIPAL, to be returned as soon as possible. D 325

THE UNIVERSITY OF LEEDS
DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for appointment to two LECTURESHIPS in the DEPARTMENT of ELECTRICAL ENGINEERING. Candidates should have good academic qualifications and industrial or other experience in one of the following fields: electric power engineering, electrical machines, electrical measurements, control engineering, or microwave engineering. Salary on the scale £1050 × £50 to £1400 × £75 to £1850 (efficiency bar at £1550), according to age, qualifications and experience.—Applications (three copies), together with the names of three referees, should reach the REGISTRAR, THE UNIVERSITY, LEEDS, 2 (from whom further particulars may be obtained) not later than 2nd DECEMBER, 1960. D 324

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

The Governing Body invites applications for A LECTURESHIP, AN ASSISTANT LECTURESHIP AND A DEMONSTRATORSHIP IN MECHANICAL ENGINEERING in the College, with corresponding title and status in the University of Manchester.

Candidates for the Lectureship should preferably have a major interest in Fluid Mechanics, Automatic Control or Theory of Plasticity, and must be prepared to do research for higher degrees in one of these fields. In addition to limited Departmental teaching, candidates for the other posts would be expected to undertake research, under guidance, in the Theory of Plasticity. Salary: Lecturer, in the scale £1050-£1850; Assistant Lecturer, in the scale £800-£950; Demonstrator, £675. F.S.S.U. and family allowances.

Conditions of appointment and form of application may be obtained from the REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, MANCHESTER, 1. The last day for the receipt of applications is SATURDAY, 26th NOVEMBER, 1960.

B. V. BOWDEN,
PRINCIPAL OF THE COLLEGE.
D 295

INSTRUCTOR (UNESTABLISHED)

MINISTRY OF LABOUR require MILLING MACHINE SETTER/OPERATOR as INSTRUCTOR (UNESTAB.) at the LEICESTER GOVERNMENT TRAINING CENTRE. Must be British Subject, experienced, fully skilled, able to teach his trade and supervise the work and maintain control of trainees. Should preferably possess O.N.C. or C. & G. Certificate or equivalent qualifications. Will be required to pass a theoretical trade test before appointment and a practical test after taking up appointment. Prospect of eventual establishment. Salary, £955 p.a. at age 30 years or over, rising by annual increments to £1030 p.a.—Write for application form to: THE MANAGER, MINISTRY OF LABOUR, GOVERNMENT TRAINING CENTRE, HUMBERSTONE LANE, LEICESTER.
D 310

CIVIL ENGINEERS

MINISTRY OF TRANSPORT: CIVIL ENGINEERS. Pensionable posts for men and women at least 25 and under 35 on January 1, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. Salary (men, London), £830-£1125 according to age, rising to £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting **S 64**.
D 312

CHEMIST OR PHYSICIST

MINISTRY OF AVIATION, Royal Ordnance Factory, CARDIFF, require CHEMIST or PHYSICIST (E.O. grade). Knowledge of analysis of ferrous and non-ferrous metals, electric-plating solutions, etc., heat treatment, electro-plating and metal finishing *or* knowledge of health physics associated with radio activity and toxicity. Qualifications: Pass degree, H.N.C. or equivalent in Chemistry or Physics; G.C.E. (A level); G.C.E. (O level) with O.N.C. Salary: £1045-£1285 (min. age 27). Opportunities (normally for those under 31) to compete for established posts.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26 KING STREET, LONDON, S.W.1, quoting reference F.761/OA.
D 311

MANCHESTER REGIONAL HOSPITAL BOARD

MANCHESTER REGIONAL HOSPITAL BOARD invite applications from QUALIFIED MECHANICAL AND/OR HEATING AND VENTILATING ENGINEERS for two posts of MAIN GRADE ENGINEER. Salary scale: £910 by £35 (1) by £40 (2) by £43 (5) by £50 (7) to £1600. National Health Service conditions and superannuation scheme.

Application forms obtainable from the SECRETARY, MANCHESTER REGIONAL HOSPITAL BOARD, CHEETWOOD ROAD, MANCHESTER 8, to whom they should be returned by 14 NOVEMBER, 1960.
D 227

APPOINTMENTS OPEN

MECHANICAL ENGINEER

Applications are invited for an appointment as a MECHANICAL ENGINEER in a large factory in CENTRAL SCOTLAND for Maintenance and Development work on heavy plant; candidates should have a degree or equivalent qualification and some experience in work of a similar nature; interesting work, prospects of advancement, Staff Pension Scheme.—BOX D 318, Offices of ENGINEERING.

ENGINEER BUYER

LEADING LONDON EXPORT MERCHANTS require ENGINEER BUYER; age 30/35, H.N.C. (Mech.) or (Elec.), minimum qualifications desirable; commercial/technical sales correspondence experience essential. Salary according to age and experience.—BOX D 305, Offices of ENGINEERING.

HEATING
HIGH VELOCITY AIR CONDITIONING AND VENTILATION

DESIGN ENGINEERS & DRAUGHTSMEN

both Intermediate and Senior, who are interested in joining a progressive Company, are invited to apply for permanent appointments with top Salaries. Pension Scheme with free Life Assurance, five-day week and Spring and Summer Holidays up to three weeks. Excellent working conditions and prospects.

Full particulars of qualifications and experience should be addressed to **BOX DA 2686, c/o WHITE'S, LTD., 72, FLEET STREET, E.C.4.**
D 315

STRESS ENGINEER

DAVY AND UNITED ENGINEERING COMPANY LIMITED—the largest producers of rolling mill equipment in Great Britain are looking for a Graduate Engineer capable of conducting theoretical and experimental stress analyses on components of steel works plant at the design stage.

He will be employed in the expanding Research and Development Department and will be responsible for the operation of a Jessop-Leech Photoelastic Bench recently installed for the solution of the more intractable stress problems. There are complete facilities for fundamental investigations in the Research Workshop, also a Field Research Team equipped to carry out stress measurement on working components.

Comprehensive amenities and Superannuation Scheme.—Apply with full details of age, experience and qualifications, to:—

PERSONNEL DEPARTMENT,
DAVY AND UNITED ENGINEERING COMPANY LIMITED,
DARNALL WORKS,
SHEFFIELD 9.
D 292

J. H. FENNER & CO. LTD.
POWER TRANSMISSION ENGINEERS
HARFLEET, HULL

ASSISTANT WORKS MANAGER

This rapidly expanding Company invites applications from men of proved ability for the post of Assistant Works Manager, Engineering Division. Duties will include the co-ordination of all aspects of production and general administration of a modern machine and fitting shop employing 350 personnel on large batch production.

Candidates should be aged 30-35 years, of Degree standard, have had a minimum of five years' experience in a similar capacity and be familiar with the latest production techniques. The ability to maintain sound industrial relations is essential.—Applications stating age, qualifications and fullest details of experience should be addressed to the PERSONNEL MANAGER.
D 301

TAYLOR WOODROW CONSTRUCTION LTD.
due to the development of the
MECHANICAL INSTALLATION DEPARTMENT
require

ESTIMATORS
and
SITE AGENTS

with experience of chemical, refinery and heavy industrial installations.

These are excellent opportunities to join a rapidly expanding department and offer scope for responsibility and advancement to men of ability. Interviews can be arranged at any time including evenings and Saturday mornings with travelling expenses paid.

Write giving details of career to:
Personnel Manager,
545, Ruislip Road, Southall, Middlesex.
D 321

SENIOR HEATING AND VENTILATING DRAUGHTSMAN

CARRIER ENGINEERING COMPANY, LIMITED, LONDON

Wish to appoint for their London Office a senior man in the Estimating Section of the Heating and Ventilating Division. The specialised requirement is knowledge of modern Boiler House equipment for high and low pressure water and steam installations, and the ability to make good layout drawings. Experience in discussing technical matters with clients and architects desirable. This is a permanent position commanding a good salary and participation in Pension and Profit Sharing schemes.

Please apply in writing, giving details of age, training, technical qualifications and past employers to the

Personnel Officer, Carrier Engineering Company Limited,
24 Buckingham Gate, London, S.W.1

All Applications will be treated in the strictest confidence and no reference made to present employer without applicant's permission.
D 338

WHESSOE

WHESSOE LIMITED REQUIRE

THREE YOUNG ENGINEERS

in the fast-expanding light products section of the Engineering Division. They should be university graduates, or have equivalent Institution exemption, and should be under 30 with at least one year's industrial experience, preferably in light engineering.

Mechanical Engineer
for design and development work, with some knowledge and experience of shop production methods in light engineering. *Reference 55/60*

Chemical Engineer
with mechanical leanings, or Mechanical Engineer, for contract work including customer contact, for which an orderly mind, an acceptable personality, and some business flair are important. *Reference 55/60*

Electrical Engineer
with a bias towards instruments and electronics with some knowledge of transistors and associated circuitry. *Reference 57/60*

These are permanent positions with rapidly expanding prospects, with three weeks holiday over 25, and generous pension and life cover; removal expenses will be defrayed and help with housing may be given. The Company's main works are in the pleasant town of Darlington which is surrounded by most attractive countryside.

Write giving full details to: The Staff Officer, Whessoe Limited, DARLINGTON, quoting the Reference number and mentioning this paper.

D 339

Sutcliffe

RICHARD SUTCLIFFE LIMITED

invite applications for the position of

MANAGER—SURFACE INDUSTRIES DIVISION

THE POST IS A VERY IMPORTANT ONE IN THE COMPANY'S ORGANISATION AND CALLS FOR INITIATIVE, ENERGY AND AMBITION. THE COMMENCING SALARY WILL BE SUBSTANTIAL AND IN KEEPING WITH THE QUALIFICATIONS OF THE SUCCESSFUL CANDIDATE. PROMOTION PROSPECTS ARE VARIOUS, AND WILL BE SET OUT IN INTERVIEW.

The Manager will be responsible to the General Manager for the control and expansion of a division which tenders for, designs and sells the Company's products for use in surface industries at home and abroad. The division has tendering and design staff at the Company's head office and technical managers situated to cover sales throughout the country.

An important part of his duties will be representing the customers' interests at all times.

Candidates should be about 35 to 45 years of age, have a good general education, and be trained engineers, preferably with a University degree, Associate Membership of the Institute of Mechanical Engineers, or the equivalent.

They should have considerable and recent experience in the mechanical handling of bulk materials, and some recent technical sales experience in this field is desirable.

There is a good insurance and pension scheme in operation.

Applications, which will be treated in strict confidence, should in the first place set out brief details of qualifications and career to date, and be addressed to:

Managing Director, RICHARD SUTCLIFFE LIMITED,
HORBURY, WAKEFIELD, YORKSHIRE.
D 288

INSPECTION ELECTRICAL ENGINEER

INSPECTION ELECTRICAL ENGINEER required for Manchester Area. Applicants should be between 25 and 40 years of age with minimum qualification O.N.C. and with some inspection experience.—Reply to BOX D 198, Offices of ENGINEERING, giving essential data and salary required.

UNITED KINGDOM AND OVERSEAS

ELECTRICAL CONTRACTING COMPANY

Offer tremendous scope and opportunities resulting from continued expansion to the following personnel. Two-year tours with home leave to U.K., Accommodation provided, local allowances and excellent salary. Permanent post.

MECHANICAL ENGINEER for Consultant's Office in Teheran. Must have had at least three years' experience as a Senior Engineer in the design of installation for the Oil or Chemical Industries. Qualifications to include Corporative Membership of the Institute of Mechanical Engineers.

All applicants must give full particulars of past and present employers and experience, together with qualifications.

N. G. BAILEY AND COMPANY LIMITED,
"HEATHCOTE,"
ILKLEY, YORKS. D 299

MECHANICAL AND CIVIL ENGINEERING

DRAUGHTSMAN

MECHANICAL AND CIVIL ENGINEERING DRAUGHTSMAN required for a Drawing Office engaged on all types of work connected with Mining, Quarrying, Hydraulics and Industrial Building Construction. A Superannuation Scheme is in operation. Applications stating qualifications, experience and salary required should be made to THE CHIEF ENGINEER, ENGLISH CLAYS LOVERING POCHIN & CO., LTD., 14, HIGH CROSS STREET, ST. AUSTELL, CORNWALL. D 293

EXPORT SALES MANAGER

required by well-known COMMERCIAL HEAVY VEHICLE MANUFACTURERS. Must have experience of both selling and documentation in the engineering export field.—Apply with full details to: BOX D 291, Offices of ENGINEERING.

MECHANICAL ENGINEER

MECHANICAL ENGINEER, H.N.C. standard, required for non-destructive testing of materials and vessels. Specialised training will be given to successful candidate. Commencing salary, £800 a year. Non-contributory pension.—BOX D 335, Offices of ENGINEERING.

VENTILATION SILENCING

SPECIALISTS in the design, manufacture and marketing of high efficiency silencers for air conditioning and ventilating systems, require a "live" man with full knowledge of all aspects of ventilation to act as their Technical Sales Representative principally in the London area. Salary, expenses and pension scheme in operation.—Full details in writing to SOUND CONTROL LTD., COLNESIDE WORKS, WEST DRAYTON, MIDDLESEX. D 337

ENGINEER

B.B.C. requires ENGINEER to assist with the design, preparation of drawings and specifications, and supervision of installation of all types of air-conditioning, heating and ventilating plants. Applicants must be British subjects and preferably A.M.I.H.V.E., and must have had several years' experience following an apprenticeship.

This post is based in London and the salary on appointment would be in the range £935 per annum to £1185 per annum, depending on qualifications and experience.—Requests for application forms to ENGINEERING RECRUITMENT OFFICER, BROADCASTING HOUSE, LONDON, W.1, quoting reference 60.E.157 ENGG. D 322

DEPUTY CHIEF ENGINEER

SÃO PAULO LIGHT S.A.—SERVIÇOS DE ELETRICIDADE, a Company in Brazil and a subsidiary of the Canadian corporation Brazilian Traction, Light and Power Company Limited, invite applications from suitably qualified men for the position of DEPUTY CHIEF of its PIRATININGA POWER STATION. The power station was completed about five years ago and is situated near São Paulo (population over 3 millions; temperate climate, 2,200 ft. above sea level). The plant comprised initially 2 × 100 MW 1800 r.p.m. steam turbo-generator units each supplied at 850 p.s.i. 900 deg. F. by one 850,000 lb./hr. oil fired boiler and has been recently expanded by the addition of two 125 MW reheat units, 1800 p.s.i., 1000 deg. F. Applicants should have sound technical knowledge and good practical experience in the administration, operation and maintenance of steam-electric power stations; should also be of strong character with an aptitude for supervision and the maintenance of harmonious labour relations. Good salary, three years agreement with first class passage both ways; four months paid leave after three years service.—Written application in the first instance should be made to MR. OSBORNE MITCHELL, GENERAL MANAGER, CANADIAN-BRAZILIAN SERVICES LIMITED, 9/12, CHEAPSIDE, LONDON, E.C.2. D 272

INSPECTION ELECTRICAL ENGINEER

INSPECTION ELECTRICAL ENGINEER required for London Area. Applicants should be between 25 and 40 years of age with minimum qualification O.N.C. and with some inspection experience.—Reply to BOX D 197, Offices of ENGINEERING, giving essential data and salary required.

SENIOR DRAUGHTSMAN

SENIOR DRAUGHTSMAN for general engineering work. Previous experience in steam engines and compressing machinery an advantage.—Write or 'phone TECHNICAL DIRECTOR, GEORGE WALLER & SON, LTD., PHOENIX IRON-WORKS, STROUD, GLOS. (BRIMSCOMBE 2301) for interview. D 314

THE UNITED STEEL COMPANIES LTD

WORKINGTON IRON & STEEL COMPANY

Branch of The United Steel Companies Limited

WORKS ENGINEER (MECHANICAL)

Applications are invited for the senior position of Works Engineer (Mechanical) in the Engineering Division, who will be directly responsible to the Chief Engineer for all mechanical engineering maintenance and for the installation of new plant. His responsibilities for maintenance will extend over blast furnaces, ore preparation and sinter plants, steelmaking plant, rolling mills, coke ovens, and ancillary services, including gas, water, roads and railways. He will lead a large staff of engineers and technicians engaged on the installation and maintenance of plant.

Sound experience of maintenance engineering including planned maintenance schemes, not necessarily within the iron and steel industry, is essential.

The salary is substantial. The company has a compulsory pension and life assurance scheme and offers a house or arrangements for assisted house purchase.

Apply in full (in strict confidence) without delay to:—
THE SECRETARY,
WORKINGTON IRON & STEEL CO.,
P.O. BOX NO. 3,
WORKINGTON, CUMBERLAND
Endorse envelopes "Personal" and quote reference WE(M). D 252

RESIDENT ENGINEER

is required by CHEMICAL ENGINEERING CONTRACTORS. Experience in the erection of heavy plant, including pipework, pumps and vessels desirable. Previous experience of civil engineering and acid resisting brickwork would be an advantage. Age 30 to 50 years. Minimum technical qualifications H.N.C. (civil or mechanical). Salary not less than £1300 per annum plus out-living allowance. Pension scheme.—Apply, quoting Reference Number SC135, to CONTRACT LABOUR DEPARTMENT, SIMON-CARVES, LTD., STOCKPORT. D 245

DEVELOPMENT ENGINEER

required by the United Kingdom Atomic Energy Authority, Production Group, Springfield Works, Salwick, Preston, Lancashire, to undertake development work and technical investigations into the application of modern engineering methods and equipment to production of nuclear fuel elements.

A recognised engineering apprenticeship and corporate membership of a senior engineering institution, or a good degree, are essential. Experience in the design or development of jigs, tools and mechanical handling equipment in light engineering production work is also required.

Salary: £860 (at age 25)-£1340 per annum, according to age, qualifications and experience.

Contributory Superannuation. Housing Assistance Schemes.

Send postcard for application form, quoting reference SF.78/J.2, to Works Secretary at above address.

Closing date: 14th November, 1960. D 300

CHEMICAL PLANT DRAUGHTSMEN

Old established and expanding company of repute offers interesting work on DESIGN LAYOUT and DETAILING OF CHEMICAL PLANT. Permanent positions and salaries to match experience and qualifications. Voluntary contributory superannuation with free life assurance scheme. Canteen facilities. Hours 9 a.m. to 5.30 p.m., five-day week. Overtime paid. Excellent working conditions.—Apply in writing giving full details of past experience and salary required, to—
NORDAC LTD., UXBRIDGE, MIDDX. D 298

ASSISTANT CHIEF ENGINEER

THE HARPER PAPER GROUP are seeking an ASSISTANT CHIEF ENGINEER to work in the Blackburn Area. Applicants must be graduates and/or Corporate Members of the Institution of Mechanical Engineers, with a minimum of 5 years' varied engineering experience in a progressive company. The successful candidate will be capable of co-ordinating all electrical and engineering work within the group, and will possess marked managerial ability. A knowledge of the paper industry is desirable, but not essential. Salary will be in the range £1200 to £1400 per annum. A Non-contributory Pension Scheme is in operation. Brief details, in applicant's own handwriting, to:—
PERSONNEL MANAGER,
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BOX D 265, Offices of ENGINEERING.

FOR ADVERTISEMENT RATES: SEE PAGE 3

Companies

Automation Brings 1,000 Jobs to Scotland

THE AUTOMATION equipment company, HONEYWELL CONTROLS Limited, are to extend their Lanarkshire, Scotland, factory, over the next three years, almost doubling its size.

Work is being started on the extension immediately, and the expansion will give jobs to another 1,000 people. The total labour force of the completed works will be 3,000.

The comment made at the ceremony announcing this move is worth quoting at length. It came from the Honeywell managing director, Mr. C. W. Spangle, who said:

"Remembering what used to be said about automation being a threat to employment, it is interesting to note that in an area where unemployment used to be a serious problem, 3,000 jobs will have actually been created by the growth in demand for automation equipment.

"By cutting costs throughout industry it has done much to help create and maintain the conditions essential to full employment."

Forty per cent of the output from the Lanarkshire works is exported. Work is currently in hand on a £250,000 equipment contract for Russian sugar and chemical plants and on a £300,000 control system for an Indian oil refinery.

Sunderland Expansion Plans for Engine Components

HEPWORTH AND GRANDAGE, producers of internal combustion engine components, are to develop a 22 acre site at Sunderland, on the North East coast.

Pressure for expansion of the company's capacity is such that what can be done at the present Bradford works under the terms of the Distribution of Industries Act is inadequate to fulfill the requirements.

At Sunderland the first steps in factory building will be taken early next year. Commencement of production is expected by the end of the year with a labour force of about 350 people. In talks with the local trade union leaders the company has been assured of willing cooperation, and there appears to be a good prospect of being able to maintain in Sunderland the happy labour relations that exist in the Bradford works.

The new development will include a new iron foundry occupying 165,000 sq. ft on two floors. This will enable the company to make a major increase in its output of piston rings and shell-moulded castings. Electric furnace melting is to be employed, together with modern automatic moulding machinery. The machine shop, 72,000 sq. ft in area, is to be used for the expansion of piston ring output for the big car companies.

Key Men Moving

Some of the key men at Bradford will go to Sunderland when preparation for production is beginning. The greater part of the labour force will be semi-skilled and recruited locally. Already some of the Sunderland men are being trained at Bradford.

The expansion on the North East coast does not mean any reduction of activity at the St. John's Works, in Bradford, where floor space and employees released by the development in Sunderland are urgently needed for the increased output of other components. Levelling of the Sunderland site, which has so far been almost entirely agricultural in use, is being done by the DOWSETT ENGINEERING CONSTRUCTION Company. The architects for the project are NEWRICK AND BLACKBELL, of Sunderland.

An Export Council For Europe

Sir William McFadzean, the President of the Federation of British Industries and chairman of BRITISH INSULATED CALLENDER'S CABLES, who has accepted the chairmanship of the newly formed Export Council for Europe, is shortly to make an announcement on the Council's membership and its terms of reference.

The FBI chairman, through his close association with the British New York Fair earlier this year and other export promoting activities, is well qualified to lead this important new body in the field where the immediate future for growth in trade is probably more promising than anywhere else in the world.

The Export Council, which is not a Government body, will work in close touch with the appropriate Government departments and will be recognised and accepted by the authorities as an accredited independent organisation.

What Mr. Reginald Maudling, President of the Board of Trade, did not say in his request to the FBI chairman, or in the subsequent announcement, was what the Government would do if the members of the Export Council for Europe, in the course of their promotion of British trade with Europe, were to become passionate advocates of the United Kingdom joining an all-European trading agreement.

Plessey Offer For Record Changer Firm

The offer of the PLESSEY Company, who are concerned with radio, telecommunications and television equipment, for the GARRARD ENGINEERING AND MANUFACTURING Company, places a value on the Garrard firm of almost £4 million.

Garrard produce record changers and record playing units and have become something of a household name among record enthusiasts.

The joint statement issued by the two companies explains that Garrard has suffered a recession in its business in the current year. Some indications exist of a more satisfactory second half, but the year as a whole is expected to be "far less satisfactory" than the year before.

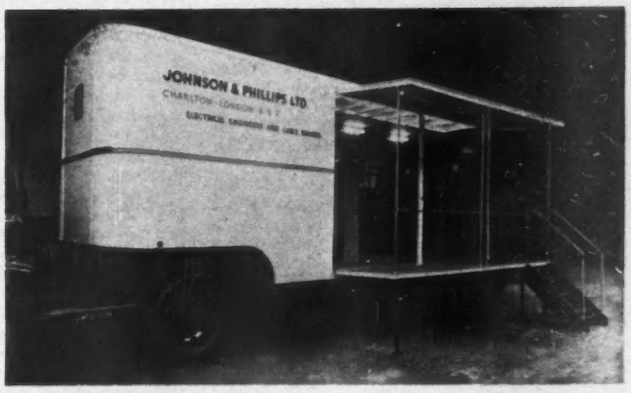
The statement adds that both boards believe a closer association between the two companies will strengthen the productivity and competitive power of the companies in a field where, until these present merger moves, the companies have operated independently.

The intention is for Garrard to carry on operating as a separate unit with its own board and continuing without any significant changes its relations with overseas associates, staff and customers. The Garrard directors have recommended acceptance of the Plessey terms and will also accept for their own shares and all the shares of which they hold the beneficial ownership.

Travelling Showroom For Electrical Equipment

Demonstrations of their switchgear, transformers, capacitors and cables are to be given all over Britain by JOHNSON & PHILIPS, the electrical engineers and cable makers, of Charlton, East London, in a newly designed mobile showroom (inset).

The new 27 ft long trailer was made for the company by CARRIMORES Limited. One of the first shows will be given in North Western Electricity Board areas, exhibiting the most recent



J and P range of air-insulated and compound-filled metal-clad gear. Another component being shown will include a compound-filled oil switch which is fitted with a manual spring-operated mechanism independent of the operator's speed of opening or closing.

An expulsion fuse-switch for the protection of overhead line equipment, suitable for three-phase systems up to 150 MVA at 11 kV will be taken along in the show.

The comfort of those representatives of larger industrial concerns, Electricity Boards, and Coal Board regions who will see the exhibitions has not been overlooked. In addition to the panelled exhibition space, a reception area has been provided, and a small kitchen has been included in order to cater for light refreshments.

A Gleam from Rover In the General Gloom

Conflicting news from the motor industry. The quality-product ROVER Company announces a much better year. Its group profit for the past financial year rose to £2,764,973 from the previous year's £1,902,046.

The Rover cars are in the group that may broadly be said to suffer less directly from changes in the hire purchase regulations. With Jaguar and Rolls-Royce cars they are more likely to be bought by companies, or at least by the senior company executives. In either case this sort of market is one not so swiftly pushed up or down by the Government's see-sawing credit policy.

The Rover figures cover the past year. The present picture of the car industry at large is increasingly bleak. September's car exports were the smallest in number since February, 1957. 29,795 cars were sent abroad in September, a drop of 11,000 from August's level and 22 per cent fewer than in September 1959.

It might be a better position if the fall could be attibuted in part to the tally clerks' strike in the London docks, but since that did not break out until 20 September no very significant part of the fall can be put down to their activities. The greater part of the disruption due to the 1,600 tally-clerks will appear in the October results.

Sharp Decline

The sharply fallen sales in the United States accounted for almost the whole of the decline in the position. The number of cars going to America was only a third of the numbers sent in September last year, and to Canada the number was only a half.

Extra shipments to the Commonwealth and to the European Common Market nations took some of the sting from the cuts. Exports to ECM countries were at the rate of 56,000 cars a year in the first nine months of the year, a more than 40 per cent increase, but by no means enough to compensate for the fall from last year's 15,000 cars a month to the USA.

South Africa, taking double the number of cars, is now the industry's third largest customer, after the United States and Canada.

Sweden, Britain's main customer within the European Free Trade Area, is also on the list of countries buying fewer cars from the UK. Three thousand fewer cars went from British ports to Sweden in the first nine months of the year.

Current total output from the car makers is now thought to be somewhere in the region of 23,000 a week, a reduction brought about perhaps more by the export decline than the hire purchase restrictions.

To this extent the balance of payments is already worsened by the failure to maintain the flow of overseas earnings from car sales. The inclination of the Treasury to avoid reducing the restrictions on home market car purchases, which is what the credit curb amounts to, must be very strong. Other industries better able to earn foreign currency can use the workers who drift away from the short time working car plants. To allow a surge of home buying to take that chance away is hardly a line of action likely to commend itself to the Government.

Balancing is a Pre-Production Study

Dynamic balancing of components can be carried out more cheaply and in a shorter time if the designer and the production engineer [co-operate.

By A. Binns, M.I.Mech.E., and P. R. Saunders, M.Sc.
W. and T. Avery Limited

DYNAMIC balancing is now regarded as a normal and necessary procedure in the production or overhaul of all rotating components, except perhaps the slowest moving. It is still, however, possible that designers and production engineers are not as familiar as they might be with the various practical aspects and possibilities in this procedure. Many components from the smallest to the largest, from the cheapest flow line component to the most expensive rotating assembly, could be produced more cheaply in a shorter time if the designer and the production engineer were more aware from the beginning of the relative merits of the various techniques—often quite different—available for balancing. They should also know the significance to be attached to various aspects of balancing, as they are related to the particular rotor in question.

One particular phrase might perhaps be emphasised: that is "from the beginning." Quite often, though proper consideration is given from the initial design stages of a component which needs to be balanced to the various other machining and production processes, it is only when the component has been completely designed or even made that the practical problem of balancing is considered in detail. Needless to say, this can give rise to unnecessary difficulties of tooling and procedure, and may even affect the accuracy with which the rotor can, in fact, be balanced.

In this article, various practical aspects of the procedure are briefly discussed with this in mind.

TOLERANCES

A basic consideration and one which can determine many of the subsequent decisions as to the best procedure, is the tolerance to which the rotor must be balanced. Ideally, a series of tests should be carried out to determine the effect of varying amounts of unbalance on the smoothness of running and on the life of a rotor, starting with one balanced as finely as possible and increasing the amount of unbalance in successive rotors until it is obviously intolerable. Particularly as regards life tests, this can only properly be done statistically with a considerable number of rotors, and it is time-consuming and expensive. In practice, it is more usual to take advantage of the experience of others and to specify a tolerance that has been found in the past to be appropriate to the class of work. A considerable amount of experience is now available and a suitable tolerance may be taken, for example, from a table such as that shown on this page.

When new developments are taking place and there is little or no past experience to draw upon, the designer is often tempted to specify an extremely tight tolerance so as to exclude the possibility of unbalance being one of his troubles, especially when there are difficulties with vibration or bearing life. It is sometimes the case that such tolerances are very difficult and costly to obtain or even to attempt to obtain, since tooling problems and the subsequent assembly or coupling of different components, may unavoidably be such as to render the nominal tolerance unrealistic.

Generally, as in all production processes, a tighter tolerance is usually more expensive both in terms of equipment required and of production time taken.

In all cases, the balance of the complete assembly is to be considered. It may, however, be very difficult to balance a complete assembly due to its size or shape. If so, and the various components are separately balanced, the way in which they are assembled is of the greatest importance. The tolerances of all mating surfaces and couplings, particularly of alignment and concentricity, have to be considered in relation to the final balancing tolerances. This aspect can hardly be over-emphasised. Balancing machines enable individual components to be balanced to a far higher degree of accuracy than can be maintained by any but the very best design and assembly practice.

Finally, the tolerance should be specified on the drawing in a realistic and precise way: for example, so many inch-ounces in two specified planes, and some reference made to the manner in which balancing is to be carried out where this is relevant.

SUPPORTING THE ROTOR

There are a number of alternative methods available for supporting the workpiece while it is rotated in the machine. Considering first the more usual horizontal axis balancing machines, generally, if the rotor is to run in ball or roller bearings the ideal way is to balance in the actual bearings to be used. It is even possible sometimes to balance a rotor running in its completely assembled machine, but it may be difficult to correct the rotor in such a case.

If the rotor runs in ball or roller bearings in the balancing machine, the outer races must be allowed to align themselves with the angular vibrations of the axis if there is dynamic or moment unbalance. This is possible if the outer races are supported on a V-roller assembly or held rigidly in a saddle bearing, the two bridges or bearing supports of the machine being tied together to form a rigid cradle.

If the rotor is more conveniently or necessarily supported at plain journals, again there are alternatives. Very light rotors can be run in V-blocks of non-metallic material. Rotors up to several tons weight can be supported on pairs of rollers in each of the balancing machine pedestals and this makes tooling very simple.

For the heaviest rotors, and sometimes for the lighter rotors for special reasons, it is necessary to run in plain bearings. This is a similar problem to that of ball bearings, and the bearing block must be allowed to align itself with the shaft. Proper lubrication must be supplied.

There is a class of rotors including single turbine or compressor stages and car flywheels, which need balancing before being attached to a rotor and have no bearings of their own. They can, of course, be mounted on a dummy mandrel and balanced on a two plane horizontal balancing machine, but it is often more convenient to mount such disc-like bodies on the plate of a vertical axis machine for one or two plane balancing. If the disc is to form part of an assembly which will subsequently be balanced in two planes, a correction in one plane for the static unbalance alone is sufficient, but two-plane vertical machines are available.

It may seem self-evident, but it is not always fully realised in practice that when special mandrels or other rotating tooling components have to be used, not only must they themselves be carefully balanced but they must be designed and used in such a way that the maximum possible error introduced by their use is appreciably less than the tolerance called for on the actual workpiece. Every aspect of this must be carefully considered.

DRIVING THE WORKPIECE

Perhaps the simplest and most reliable form of drive for general purpose balancing is the flexible or cardan shaft drive. Usually, this gives a positive end location to the rotor and allows a type of balancing machine construction which is particularly straightforward and dependable. Disadvantages are that the end connection to the rotor may not be easy, even if the designer has thought of it beforehand, and there is a limit to the ultimate accuracy that can be achieved due to the mass and difficulty of exactly concentric attachment of the drive shaft.

After a direct drive, the most common is the belt drive. This is very versatile and it may not be necessary to fit a special pulley, the belt driving directly on to a suitable diameter and surface of the rotor. No direct coupling is necessary and insertion and removal of the rotor can be speedy and convenient for the balancing of small rotors. Some special form of end location may be necessary, and it may also be necessary to add a reference mark or strip to the rotor to assist location of the unbalance.

Ideal for small squirrel cage or short circuited armatures is the rotary magnetic field drive, Fig. 1, allowing extremely short balancing times to be obtained. This type of drive usually has to be made specially for a particular type of armature and is hence only used for series production balancing.

For bladed rotors, particularly small ones, or even unbladed rotors with a notched or serrated

TABLE:—*Permissible Residual Static Unbalance, Measured in Inches, of Displacement of Centre of Gravity from Bearing Axis*

Type of Rotor	Speed (r.p.m.)					
	300	1,000	3,000	10,000	30,000	100,000
Gyroscopes; armatures, shafts and wheels of precision grinding machines				0·000006- 0·000015	0·000002- 0·000005	0·0000006- 0·0000015
Small armatures with special requirements; grinding machine drives, gas and steam turbines and superchargers with special requirements			0·00005- 0·00012	0·000015- 0·000040	0·000005- 0·000012	
Small armatures; medium and large armatures with special requirements; turbo-generators; gas and steam turbines and blower rotors		0·0004- 0·0010	0·00012- 0·00032	0·00004- 0·00010		
Normal armatures, machine tool and general machine parts; fans; crankshafts of engines with four or more cylinders; flywheels; process plant; centrifuge drums and cardan shafts with special requirements		0·0010- 0·0025	0·00032- 0·00080	0·0001- 0·00025		
Cardan shafts; crankshafts for 1, 2 or 3-cylinder engines (with uncompensated reciprocating forces); car wheels, wheel sets, crushing and agricultural machinery	0·008- 0·020	0·0025- 0·0060	0·0008- 0·0020			

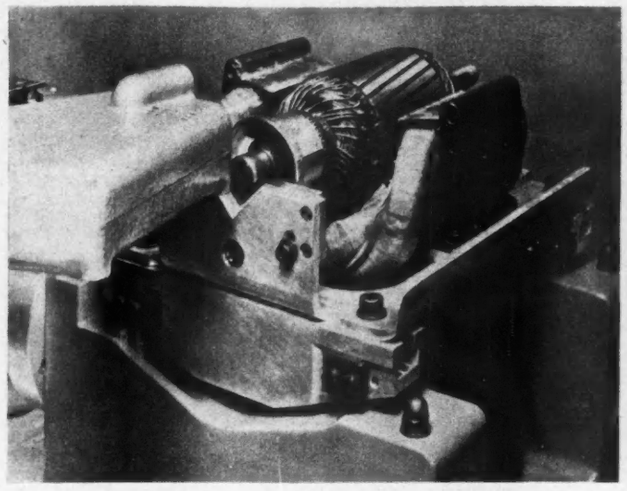


Fig. 1 The rotary magnetic field drive for small squirrel cage or for short circuited rotors.

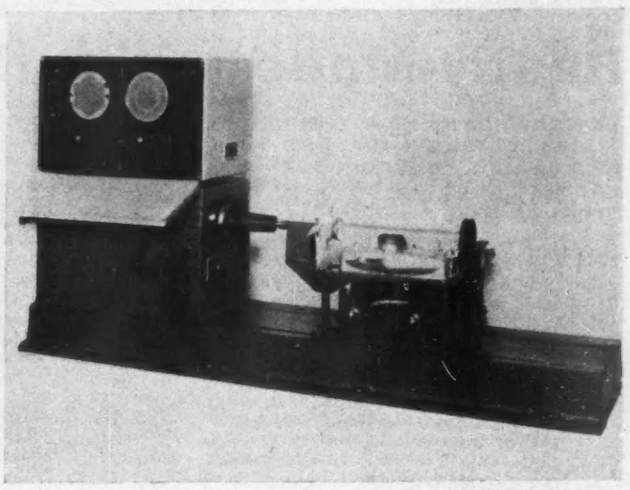


Fig. 2 Polar light spot indication being used for a six-bladed fan at one end of a rotor and a pulley disc at the other.

surface, a jet of air may be suitable driving medium and very high rotational speeds can be obtained by this method. A high degree of accuracy can be achieved in this way.

For a complete electrical assembly, for example a small motor or gyroscope, the rotation can be by normal means, flexible cables connecting the supply.

TESTING SPEED

The majority of balancing machines have a speed sensitive form of indication so that the greater the speed at which the rotor is turned the greater the indicated read-out for a given unbalance. Hence it may be easier to balance to a very fine degree of accuracy if the rotor is run at high speeds. However, it is often the case that there are reasons why the rotor speed should be above or below a certain limit determined merely by the construction of the rotor. It is rarely necessary to balance at precisely the normal operating speed of the rotor unless there are flexible elements, such as windings, which will change their position continuously with change of speed by an amount significant in relation to the tolerance. This should not be confused with the case of rotors running near or faster than their first critical speed.

Rotors with loose pin-jointed blades or other inevitably loose components must obviously be run at such a speed that the centrifugal force steadies the loose parts in the position they will adopt at normal working speed, and so a certain minimum speed has to be specified.

Reasons for keeping speed down are more frequent. Rotor windage power with fans or other bladed rotors increases very rapidly with speed if shrouding is not used. Crankshafts which do not have balanced webs and crank pins distort to an appreciable extent at quite moderate speeds. If this distortion is not restrained by a cradle and if it is not possible to support them in the machine at the " nodes " of the distortion caused by rotation, it is necessary to lower the speed until the error due to distortion is small compared with the tolerance.

With all rotors, the accelerating and braking times and the wear and tear of the machine obviously depend on the speed and the motor power. The lower they are the better. Modern balancing machines are so sensitive that a fairly low speed, say 500 to 800 r.p.m., is usually adequate.

TYPE OF INDICATION

Usually, the operator of a balancing machine merely wants to know how much material to add or remove at which angular position in each of two predetermined planes. There are different ways of giving him this information. He can read the amounts and angles separately on different meters, or he can read both amount and angle from the position of a spot of light on a polar screen, or a hand-set chart, having read the unbalance components at right-angles from a meter. Alternatively, the amount may be indicated on a meter and the angle by stroboscopic means. By employing suitable switching the unbalance in one plane at a time can be indicated or, except in the case of stroboscopic indication, in both planes simultaneously. In the latter case, it is convenient if the indication can be registered or locked for reference after the rotor has stopped so that recording during operation is unnecessary.

Not infrequently, correction is only possible or convenient at certain angular positions around the circumference, for example by grinding a small amount of material from the ends of the blades of an impeller or fan. There may be a number of such positions and the operator must then know how much to take off which blades rather than at which angle the nett amount is to be removed. The information can be obtained either by plotting the nett unbalance and its position on a suitable reference chart and reading the components required or directly from the vectormeter type of instrument. Fig. 2 shows an instance in which the polar light-spot indication is suitable for the 6-bladed fan at one end of the rotor and the pulley disc at the other.

Some rotors may require a special form of indication on account of their shape. For example, six cylinder crankshafts can usually only be corrected in limited angular sectors, distributed at intervals of 120° round the rotor and spaced along the rotor. Suitable forms of indication have been devised for this case.

CORRECTING UNBALANCE

Perhaps the first point to make about the correction of unbalance, which should be regarded as a design consideration, is that, if dynamic unbalance is to be corrected, then the further apart the two planes are the better, since a smaller amount of material will need to be added or removed to correct. It is often very difficult to correct a disc-like rotor for pure dynamic unbalance if the only available planes are very close together on opposite sides of the rotor.

To correct the static component of the total unbalance, it is rather better to have the two planes of correction on opposite sides of the centre of gravity of the rotor. In practice, of course, the pure dynamic and static unbalances are not usually separated but the above considerations remain the same. The choice of planes obviously goes hand in hand with the natural shape of the rotor and a suitable means of correction.

Careful thought given to the means of correction can save much time in production. Clearly material can be added or removed, or perhaps a light component can be exchanged for a heavy one. Generally, removal of material by grinding, milling or filing is not very precise either in amount or in angular location, but an operator soon becomes very proficient at it. Drilling lends itself more readily to precise control and tables or charts can easily be prepared relating depth of drilling to indicated unbalance. It may be advisable to have special bosses incorporated in a component for correction purposes to avoid weakening or changing the shape of a web or blade, or it may be advantageous to design with a deliberate mass bias so that correction can always be made in a certain sector of the rotor when it would be difficult or undesirable to remove material elsewhere.

The addition of material by soldering, metal spraying or welding of small pieces of plate can be used for correction. With the latter method, the pieces can be ready cut in suitable sizes for flow line work. Rivets, screws or other types of insert can serve the same purpose. Needless to say, the indication of unbalance should be such that no calculations on the part of the operator are necessary to choose the right correction weight.

SPECIAL PROBLEMS

In this article an attempt has only been made to review the different aspects and possibilities involved in dynamic balancing as a production process, considering for the most part general purpose or comparatively straightforward balancing. There are other aspects which can only be briefly mentioned here.

Rotors which run near to or faster than their whirling speeds require special machines and special techniques. If very large quantities of rigid rotors are concerned, it may be worthwhile for the overall process to mass centre the forging or casting before other machining commences, i.e., put in the initial centres on the mass axis or in a known relative position to minimise subsequent removal of material, both in machining and final balancing.

An inevitable step in the age of automation has been the combination of the correction process automatically with the balancing process, so that after loading, the rotor has its unbalance measured, corrected, and its final state checked completely automatically. Finally, a word might be said of the possibilities of balancing *in situ*. This involves measuring and analysing the resulting vibrations of a complete machine to deduce the state of balance and correction required. This requires skilled and experienced engineers.

Acknowledgement.—The authors wish to acknowledge the assistance given by W. and T. Avery Limited and by Professor K. Federn of Carl Schenck GmbH who provided the table.

Ready-Made Resins that are Easily Moulded

The development of resins formulated ready for use now makes it economical for general engineering works to produce their own mouldings.

MANY of the problems met with in the early days of glass fibre moulding have been solved in the hard school of experience by specialists in this type of work. The technique, which looks very simple on paper, does require considerable practice to obtain fully satisfactory results and most users of moulded components have until recently been content to obtain them from custom moulders. However, there are many advantages in producing one's own mouldings, such as better control over completion dates, greater ease in carrying out modifications and better integration with fabricated parts where mouldings form part of a larger assembly.

EASIER HANDLING

One of the main difficulties facing an engineering firm intending to make its own mouldings is the degree of specialist knowledge which has been required in the past to specify, prepare and control the ingredients of the plastics. Apart from the surprisingly wide range of polyester resins from which to choose, there is the problem of the addition of the correct quantities of the appropriate types of hardener, accelerator, fillers and pigments, the selection and admixture of which call for experience and special equipment.

This side of the work has been greatly simplified by the introduction of fully formulated resins, which are supplied virtually ready for use, and require no great skill in their handling. This has made it possible for firms with little experience in this field to undertake moulding at very reasonable capital outlay and to produce excellent results with a little practice.

An illustration of the success which can be obtained by a general engineering works in producing its own mouldings is provided by Sheepbridge Equipment Limited, a member of the Sheepbridge Engineering Group. This company has for some time been producing moulding for use in equipment manufactured within the group. As a result of its successful experience, it now offers a wide range of finished articles in reinforced plastics.

The largest part of the output is in the form of moulded cabs for mobile equipment, such as on the Bray Loader illustrated in Fig. 1. This cab, moulded in one piece, is stronger and lighter than its steel equivalent, requires no maintenance or painting, is much less noisy, and has a virtually unlimited life. The possibilities of reinforced moulding have been exploited to the full in making use of deep double curvatures to provide great stiffness, and in devising an ingenious sliding door which wraps over the roof, making entry and exit very easy.

The mouldings are laid up in the now familiar manner in contact moulds, one of which is shown in Fig. 2. A feature of the cabs is that they are designed to be interchangeable and to be fitted to vehicle bodies without individual tailoring. To ensure the required dimensional accuracy and stability on mouldings of this size, the moulds must be very rigidly constructed. The mould illustrated is built up from reinforced plastics, laid up on an original pattern of wood and plaster. It is stoutly reinforced by moulded-in steel tubes, one of which can be seen at the top of the mould, representing the bottom of the door opening. The mould skin is built up from several layers of glass mat, the effect being to provide an extremely rigid structure. To facilitate removal of the cured moulding, the mould is split at the corners, the separate panels being held together by bolts and wing nuts.

Laying up is carried out in the usual way, using a gel coat to provide a good outer finish on the shells. The first glass mat is a fine tissue where appearance is important. The resins, specially formulated for this job, including the specified pigments, are supplied by Artrite Resins Limited, of Kingsway, London, WC2, after consultation and trials. At Sheepbridge only the required quantity of liquid hardener is added immediately before use: this presents no difficulty. The resins are slightly thixotropic to prevent drainage on vertical surfaces, and are formulated to produce rapid and thorough wetting-out of the glass fibres, perhaps the most important factor in the production of strong mouldings.

The principle of complete formulation under controlled conditions is applied to polyester resins designed for many different end uses and methods of production. Some have the emphasis on hardness and impact strength, some are unusually resistant to sea water, others have strong fire resistant properties, while different balances can be struck to order between the time available for laying up and the speed of curing demanded. Formulations are adjusted to give the best properties for laying up in conventional contact moulds, for matched moulds, or where heat and pressure are applied during curing. A recent addition is a range of special resins for application by the new spray-up technique, in which the simultaneous application of resin and chopped glass rovings from a special multi-nozzle gun offers large savings in time and labour, and ensures complete wetting of the fibres with a minimum need for subsequent consolidation.

While the contact mould principle, using plastic moulds, is undoubtedly the most economical where moderate quantities of large and complex components are required, metal tools have real advantages when relatively simple profiles, or very high outputs are involved. They have a virtually unlimited life, produce mouldings of high dimensional accuracy and excellent finish, and are more easily cleaned between moulding cycles. An example of simple metal moulds used by Sheepbridge for the production of double-skinned cab doors is illustrated in Fig. 3, which also shows a neat method of obtaining maximum structural stiffness by what is virtually a one-piece box construction. The moulds are made at low cost from steel sheet. The outer door skin is laid up in a flat mould, and the inner in a mould having raised flanges and raised surfaces in the flat areas. When the two moulds are mated, as shown in Fig. 3, the raised areas and flanges of one moulding combine with the other moulding where they touch. After curing, the two mouldings form one inseparable part incorporating hollow channels which confer extreme stiffness on the finished door without appreciably increasing its weight or thickness.

Fig. 1 This Bray Loader has a cab moulded in one piece from reinforced plastics.

EXPANDING MARKETS

The combination of intelligent tooling, good design and the availability to order of resins ready formulated to match virtually any requirement, have resulted in a rapid expansion of Sheepbridge's activities, from meeting the demands of the associated companies to the production of a wide range of equipment which is selling well at home and abroad. Among the most successful may be numbered portable cement silos, prefabricated site offices (which have proved able to stand up extremely well to severe tropical conditions without maintenance of any kind), bus shelters, elevator buckets, welding masks, trolleys and a range of pallets.

Fig. 2 Cabs are laid up by hand on reinforced plastic moulds, using Artrite polyester resins which are supplied fully formulated for use.

Fig. 3 Moulds fabricated from steel sheet are used to turn out cab doors incorporating hollow beams for rigidity.

Keeping the Cost of Motor Racing Down

Formula Junior was introduced to reconcile low-cost motor racing with the classic conception of open racing cars, dear to public and promoters. Though costs have risen, there is lively interest.

By Brian Lister

SINCE the very beginning of motor racing one of its main problems to any actual or potential participant has been the enormous cost of supporting even a small team of cars.

In the past there have been many attempts to reduce this cost. For example, the Formula 2 class of racing was introduced originally to enable smaller factories to compete among themselves in a class of racing that they could afford. Formula 1 was beyond most of them, especially when companies such as Daimler Benz and Alfa Romeo were in motor sport with the backing of their very large manufacturing organisations.

In the two-seater field, of course, grand touring cars (of which a hundred must have been produced in any one year) are a much cheaper class to race than the so-called sports racing car class. But to enter racing today with either a Formula 2 or a grand touring car would mean the outlay of at least £2,500 on a suitable vehicle.

With the demise of the 500 c.c. class of racing car due to lack of competitor and public interest, in particular on the Continent, there was obviously an opening for another cheap class of motor racing.

If it were possible to put a racing car on the market for £1,000 or thereabouts, and if maintenance costs could be kept down it would mean that many more people would take up the sport. If the cars really looked and sounded like racing cars, promoters would be willing to run races, because the public would be more likely to pay to see them. (One of the troubles with the 500 c.c. class was that while they resembled racing cars, owing to the fact that they had motorcycle engines, they sounded like motorcycles.) In this way, it was argued, new drivers would come to the fore and the good ones would eventually take their places in Formula 1 cars. One of the countries most in need of new recruits in this field was Italy.

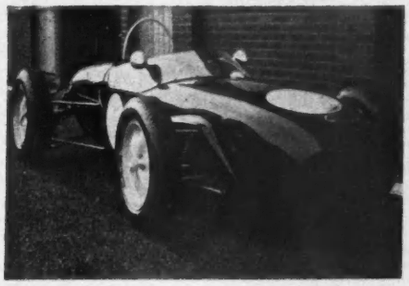
Count Johnnie Lurani, the ex-Italian racing motorist, therefore originated the idea of a Junior Formula. He suggested this to the Automobile Club of Italy as early as 1956. After handing the suggestion over to the CSI the proposals were adopted in the main by October 1958.

The basic idea of Formula Junior is that engines of 1,000 or 1,100 c.c. used to power these cars should be taken from production models (overhead camshaft engines are barred even from production cars), and that drum brakes should be employed if drums are the type fitted to the car from which the engine is taken. A minimum weight limit of 880 lb for the 1,100 c.c. cars, and 792 lb for the 1,000 c.c. cars, is imposed, and they have a starter and carry a battery.

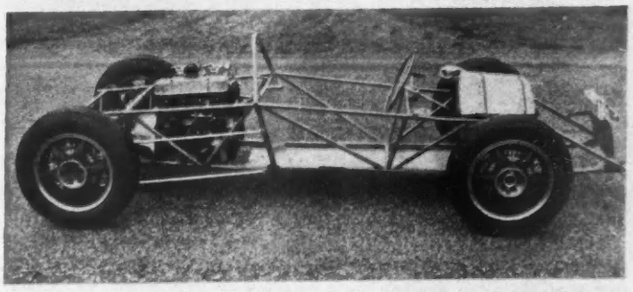
To discourage expensive engine modifications it is against the rules to change the stroke, although the bore may be altered either up or down in order to comply with the regulations. The bodies must be open single seaters, and again this restriction eliminates expensive all enveloping aerodynamic bodywork. It also means that the cars look like the classic conception of open racing cars, and this again pleases the public and promoters alike.

Only commercial fuel may be used. This rule has two advantages, namely, special fuels and ultra-high compression ratios cannot be employed thus saving needless expense in obtaining fuel and preparing engines to run on it; and, of course, it interests the petrol and oil companies, which are very much the backbone of racing.

Naturally, the Italians were the first to produce cars in the Formula Junior class, Stanguellini being the largest producers and having the most successful Italian car. This model, as with most of the other cars from Italy, is fitted with the Fiat 1,100 c.c. engine. It has independent front suspension made up from Fiat 1,200 c.c. parts, and a live rear axle with radius rods and coil springs. By 1959 Italian Juniors were being produced by some dozen companies, and



The Formula Junior Lotus, so far the most successful in its class.



The Emeryson Formula Junior chassis, recently announced.

although most of the producers were using the Fiat engine and were fitting independent front suspension by wishbones and coil springs, there were considerable differences in the rear suspension systems used. Some were fitting live rear axles with radius rods and quarter elliptic springs, others with radius rods and coil springs. One firm was using a de Dion axle with coil springs, and others were using wishbones and coil springs. Germany, France, the United States, Holland, and other counties also got off to a quick start.

Races were therefore run on the Continent throughout 1959. British contenders got off to a late start in Formula Junior. One or two were produced in 1959, but the major successful racing stables like Cooper, Lotus and Lola did not produce any cars until 1960. The most successful car made so far in this Formula is the Lotus, which has won very many races, in this class in Britain and on the Continent.

The car is a complete departure for Lotus. Hitherto they have been strong advocates of front-engined cars, but prompted no doubt by the highly successful rear-engined Formula 1-Formula 2 Cooper, they made a switch this year to rear engines successfully showing beyond much doubt that it is the logical place for the engine in the light racing cars of today.

The engine used is the Ford 105E of 997 c.c. with overhead valves and four cylinders fitted with a pair of twin-choke Weber carburettors. The engine is installed in unit with the Renault Dauphine gearbox fitted with special ratios. The front suspension is, of course, independent and made up from Standard 10 parts; springing is by combined coil spring and telescopic damper units. The rear suspension is also independent, and employs the fixed length shaft with Hardy Spicer joints at each end. It acts as both a drive shaft and a top wishbone. A single lower wishbone is also fitted. Fore and aft location is by radius rods. The body is rather angular, and here again is a departure for this firm, as in the past Lotus have been advocates of aerodynamic bodies. They have probably come to the conclusion that as wheels must be out in the airstream in this class anyway in order to conform with the regulations, it would be a waste of time to fit an aerodynamic single-seater body. The best thing that can be done under these circumstances is to keep the body as small as possible.

The basic design of the car is very similar to the Lotus Grand Prix car, and there is no doubt that any driver who has become familiar with the handling characteristics of the Formula Junior Lotus would take little time to master the Formula 1 version. It would therefore appear that one of Count Lurani's original ideas was right. Whether the cost factor is so successful is another question.

Already the cost of many Formula Junior cars has crept up to £1,350. There is also a disturbing tendency for some factories to compete in the field with "works" cars. This practice means that the amateur, for whom the class is intended, is being ousted. Experienced Grand Prix drivers are banned from Formula Junior racing, but many star Formula Junior drivers are also driving successfully in their first year of Grand Prix events. Next year they will, of course, be banned from Formula Junior, but one wonders whether the rule should not come into effect as soon as they have driven in their first Grand Prix.

So far Coopers have not taken a great deal of interest in Formula Junior, only producing a few cars mainly fitted with BMC engines. The cars are similar in basic conception to their Formula 1 and Formula 2 vehicles. They have probably wisely concentrated on one job at a time, and this year they have been winning the Formula 1 constructor's championship, and giving the World Champion, Jack Brabham, the fastest Grand Prix car available.

Next year may very well see a rear-engined Formula Junior Lola. Knowing how well this year's cars have gone, it would be a formidable contender. Gemini changed from a front to rear-engined car in the middle of the season, and practice reports of the new car suggest that it is very fast indeed.

Recently both Emeryson and Kieft have announced new Formula Junior cars, so it is obvious that next year we shall see a considerable livening up in this class in Britain. Many claim that Formula Junior racing is dull at present, but this verdict is inevitable when one make is having so much success. But that could change in 1961, and the advocates of Formula Junior are already saying that it could be the Formula 1 of 1965.

On the Shelf

By Frank H. Smith

ONE of those Great Thoughts that occasionally come to me concerns my relations with the Department of Scientific and Industrial Research. For many years I have managed to do without their services but a fresh youth from College—sorry, a youth fresh from College—insisted on seeing some Russian stuff so I had to invest in a book of Science Library forms. Fair enough. Everybody has to. But a week passes and DSIR sends in a request to borrow something from me. If I lend it (and I will if I can) it doesn't cost them a bean (apart from the time taken by a messenger to ride a bicycle two miles). Ain't there no justice? Or am I a fool for not charging? I don't think I can anyway.

Twelve rampant bodies form the Council of the Roads Campaign Council (15 Dartmouth Street, London, SW1) which now has a mouthpiece with No. 1 of *Missing Links*. No price is shown but I imagine a bona fide inquirer would get it for the asking. The target of the publication is road schemes which await Ministry approval and financial support and which, though considered vital, have not so far found a place in the road programme.

EFTA Bulletin is a first-ever from the European Free Trade Association and obtainable free from the Central Office of Information at Hercules Road, Westminster Bridge Road, London, SE1 (WATerloo 2345, Ext. 382). The first number is chiefly concerned with putting you in the picture with EFTA. Could any man be more aptly named than the Secretary-General, Mr. Frank Figgures?

Just in case you are interested in the Arab scene I offer the news that Office de Presse et d'Edition at 5 Bd Ney, Casablanca, are starting their new specialised service (hitherto in French only) in English on 1 November. It costs £10 a month by air mail and £2 less for sea mail. I'll say no more but leave it to you.

I imagine that the list of those interested in pitch fibre drain pipes is pretty short, but in case anybody wants to know more I suggest he asks Key Engineering Company Limited (Larkfield, Maidstone, Kent) for their *Key News*, number one of which is just out.

I just do not know how the Society of Automotive Engineers does it (do it?). They have their Transportation Meeting at Minneapolis, 25-27 October, their Powerplant Meeting at Cleveland, 31 October-2 November, and Fuels and Lubricants at Tulsa, Oklahoma, 2-4 November. Miss Fran. Weeden, their meetings organiser, is going to be living out of an overnight bag for a while, I can see. And incidentally there are about 34 papers resulting from this lot and she is responsible for those too.

What is, I suppose, an epoch making announcement from Heinemann (Windmill Press, Kingswood, Radworth, Surrey), is contained in a circular telling us that as from 1 October they will pay carriage on all orders from the home market and outside the London delivery area (midwives please note), for a trial period of one year. Exceptions are where books are sent direct to a bookseller's customer and where a special method of dispatch is requested (pigeon post?).

If you want a copy of the Aslib Electronics Group Membership List you had better try Aslib (3 Belgrave Square, London, SW1) as I can't find any indication of where you should apply on it.

A letter comes from a bi-monthly journal called *Degree*, which caters for the university reader. November is the month for the kick-off but I don't *think* it is for us. Typical titles: "Fables of Fleet Street," "Blues Revisited," "Chelsea—Soccer Shockers," "The New Morality." I'm all for progress but I do not like to see chelsea, nyasaland, or even britain, printed that way.

More Programmes, Better Definition?

Television Field Trials of 405-line and 625-line Systems in the UHF and VHF Bands, 1957-1958. *British Broadcasting Corporation.* (20*s*)

The series of trials reported in this BBC publication was intended to kill two quite different birds with one stone. In the first test period, a 405 line signal was radiated simultaneously on Band I (45 Mc/s vision carrier) and on Band V (654 Mc/s) in order to compare the effective service areas of transmitters on the two wavebands. In the second period of the tests, the Band I transmission continued but the Band V transmission was changed over to the 625 line (or CCIR, or Continental) standard. This arrangement was adopted for economic reasons, though obviously not an ideal one, since the 405 line and 625 line systems could never be compared simultaneously under exactly the same conditions.

The necessity of investigating the service obtainable when using ultra-high-frequency transmission has arisen owing to the lack of space in the existing bands for additional alternative television programmes. One such extra programme might just be accommodated in Band III, but certainly not the three extra which a TV-addicted public is thought to desire.

Much information is, of course, already available, mainly from America, upon the field strengths to be expected in Bands IV and V (470 to 960 Mc/s). The BBC survey agreed, in general, with previous results, which can be roughly summarised by two statements.

(*a*) The *average* field strength is about the same (for a given ERP and aerial height) over the whole range of frequencies from 40 to 1,000 Mc/s, with the exception that cut off beyond the horizon is more rapid at the higher frequencies.

(*b*) The *local variations* in field above and below this average become steadily worse as the frequency is raised.

A more difficult and uncertain question is the field strength required for satisfactory reception. If external interference is absent, we can take as a rough rule: field required in microvolts per metre is numerically equal to twice the frequency in megacycles. But, in practice, interference, whether from car ignition systems or from tropospheric reflection, is much more severe on Band I, so that the field required here may reasonably be taken to be as great as that required on Band III (200 Mc/s), though still less than that for Band V.

The BBC survey also included systematic picture quality assessments by engineers in mobile laboratories, and by home viewers with receivers approximating to normal commercial designs. A particular effort was made to cover the practical and subjective aspects, and the assessment of results has been clarified by a large number of statistical diagrams and tables.

The overall conclusion is that the power required in Band V is about six times that required in Band I for a given percentage of satisfied viewers in a given service area. Even then, the more distant viewers will obtain a cleaner picture (in other words, less background noise) on Band I, except when external interference is present. So it is clear that the extra programmes on UHF will only be obtained at a considerable extra cost.

We may turn now to the very controversial question of the improvement in picture quality obtainable by changing from our present 405 line system to the 625 line system now in use over most of the continent of Europe. In the opinion of the viewers in the BBC tests:

(*a*) the "sharpness" rating of the pictures was not significantly changed;

(*b*) the visibility of the lines was decreased on the average from "definitely perceptible but not disturbing" on 405 lines, to "just perceptible" on 625 lines; and

(*c*) The overall picture quality was not appreciably altered, though slight differences were observed in such factors as noise and synchronising.

These results agree with the view of the present writer that the only significant difference between the systems lies in the visibility of the lines, so that those users who (like the writer) are not normally conscious of the presence of the lines, show no definite preference for the 625 line picture. But this view is by no means universal among engineers, many of whom would argue that the increase in vertical definition (the horizontal is unaltered) gives a noticeable improvement. In particular, Jesty describes experiments (based upon choice of viewing distance) from which he concludes that the 625 line picture would be generally preferred to the 405 line picture *even* if the horizontal definition of the former were halved (that is, video bandwidth reduced to 2·5 Mc/s).

Whatever may be the effect (and the validity of Jesty's arguments is open to question) of the larger number of lines in critical tests under ideal laboratory conditions, it seems likely that most domestic viewers will not notice any great improvement if the system is changed, and may well conclude that the advantages of the 625 line system have been exaggerated, at least in the popular press. Much can still be done to improve picture quality on the present system by attention to detail; we should be very rash to expect the *average* picture on a 625 line system to look as good as the best present transmissions viewed on a receiver which has been correctly aligned and correctly tuned.

M. V. CALLENDAR

Market for Capital Equipment?

Manufacturing Processes in Canada. Edited by K. C. LIVINGSTON and T. C. GRAHAM. *Toronto University Press; Oxford University Press, London.* (84*s*)

Much is said about the need to export more British goods to the Commonwealth. Canada has always occupied a prominent place as a potential market. Much time and money has been spent in persuading the Canadians to buy British. Yet the question, what do Canadians want in the way of British capital goods is exceedingly difficult to answer.

We know that they want electricity generating plant, farm machinery and mining equipment. But information about Canadian industry in this country tends to be scrappy, and technical equipment still tends to be sold in that market by newcomers through occasional sales forays rather than by a careful study of Canadian industrial processes.

Information about the Canadian market for technical equipment is not easily obtained. Anyone thinking systematically about entering that market for the first time would not find it easy to assemble a coherent body of information concerning the Canadian economy and Canadian industrial processes. Details of key Canadian industries, the size of their markets, the technical processes they use and the degree of competition they encounter from the United States both in the home and export fields is not to hand in an assimilable form. Yet such information is necessary for any preliminary organised consideration of the Canadian market before salesmen or executives set out to see and sell.

This book goes some way to filling the gap, although it has not been designed for the purpose. It has been written as an account of manufacturing process in Canada for the guidance of Canadians. The individual chapters have been written by persons and organisations in these particular industries. There are seventeen indus-

tries covered and the information is technical rather than economic. Much of what is written about processes as such is available in many books on this side of the Atlantic but it emphasises technical procedures peculiar to Canada. It ranges from beef to wool textiles. It therefore provides a guide for the exporter to Canada's industrial processes.

From the viewpoint of this country, and possibly for the Canadian too, an introduction indicating the relative importance of these industries, their scale of operation, markets and so on would have been useful. This treatment would also have served to offset the dangers of having experts in an industry writing about their own processes for outside consumption.

The big omission, however, is an index. This is a book to refer to. Its illustrations and charts are good but 304 pages of double column text and illustration is hard to digest except in modest portions. The omission of an index could be remedied perhaps in later editions. As it is the book is a useful work of reference for technical and industrial companies' libraries where access to technical knowledge about Canadian industry is desirable at short notice.

G. E. TEWSON

Twist Resisting Instruments

Torsion Devices: A Survey of their Design, Construction and Use. By P. J. GEARY. BSIRA Research Report R.249. *British Scientific Instrument Research Association, South Hill, Chislehurst, Kent.* (21*s*)

This, the third book in a series surveying the literature on functional units in instruments, sponsored by the British Scientific Instrument Research Association, is complementary to the first survey which was entitled *Flexure Devices*. It has been eagerly awaited by those who possess the two earlier books. *Torsion Devices*, which must be the result of many months of patient, careful and detailed research, reaches the high standard which one has come to expect from the author, who has made a praiseworthy attempt to cover an extremely wide field within the confines of one volume.

The purpose of the book is to provide a source of information on the design, construction and functioning of the working parts of measuring instruments, and it is designed to aid two classes of readers; students and practising engineers in development and research work. It will also be useful as a reference in advanced laboratory courses which are concerned with evaluating the performance of measuring instruments.

The book commences with a list of symbols which are used in the text, and although the majority of them are traditional it is a good plan to include such a list in a book of this nature for the sake of completeness. Following the list of symbols, and exclusive of the bibliography, the book is divided into eight sections. The first section is an introduction, but is quite short, and explains the grouping and scope of the survey; it emphasises that the book is not concerned with the design of complete instruments containing torsion devices, but only with the design of the torsion devices themselves.

The second section, headed " Torsion Theory," presents some introductory theory relating to the behaviour in torsion of single elastic members having elliptical, circular and rectangular sections, and also considers the three sources of resistance to twist in a torsion member. The derivations of formulae are not all original, but in every case where previously published material is used the source of the formulae is given.

Torsion suspensions, the subject of the third section, deals quite thoroughly with the applications to instruments of filar suspensions of the single or hanging type, and also of the double or taut system. Methods of attaching the ligaments are discussed in detail, and tensioning and shock absorbing devices suggested. There is a tendency towards the replacement of pivot bearings in indicating instruments by taut suspensions, and the design features of an instrument of this type are given together with a most interesting sketch of a typical system. The static sag which must accompany the tilt of a taut suspended member is analysed, and the optimum dimensions of the suspension strips to be employed are recovered.

Section four deals with the materials used for suspension ligaments, and covers the relevant physical properties which must be considered when selecting these elements. Section five is concerned with the application of bifilar and trifilar suspensions, covering the derivation of formulae for evaluating the torsional constants of the systems and a comparison of their torque characteristics. Spiral or helical springs are occasionally employed as suspension elements, and section six summarises the basic formulae associated with these members.

Section seven shows how torsion hinges may be used as an alternative to flexure hinges when an elastic hinge is required for a moving part; several alternative designs are illustrated, and suggested methods of fabrication can quite easily be followed.

Section eight, entitled " Torsional Magnifying Devices," is most comprehensive and considers in detail magnifiers of the following types: skew bifilar and trifilar, twisted strip, coiled strip, twin strip, Kelvin bifilar, remotely actuated mirror and serpent spring. Where appropriate, mathematical expressions for the magnification obtainable have been derived.

The book concludes with a very good bibliography of 259 selected literature references with abstracts and annotations. It is an exceptionally useful book which should be in the possession of all those who are interested in the design of instrument mechanisms.

H. F. HARRISON

To Make a Meeting Go Like Clockwork

Organizing the Technical Conference. By HERBERT S. KINDLER. *Reinhold, New York; Chapman and Hall, London.* (48*s*)

The usual inference of the now outmoded term " the two sides of industry " is that of management and workers. It would probably be equally correct to state that industry is divided into the following two sections: one concerned with organising conferences and the other with attending them. It is axiomatic of this era of increasing specialisation that the specialists need to meet one another for a variety of reasons, but mainly either in order to review current developments in their own field or in order to help tackle mutual problems.

It would be hard to find a person in British industry who had not had occasion to attend at least one conference, whether on determining national industrial policy or shop floor welfare, or some other aspect of industrial organisation.

Unfortunately very many conferences leave a great deal to be desired, either in the content matter, the administrative arrangements, quality of speakers, or some other aspect. As a consequence those individuals or committees saddled with the responsibility of organising conferences rarely feel (if they are honest with themselves) that they have fully measured up to their responsibilities.

It is timely, therefore, that there is now available for technical conference organisers a guide which, if adopted fully, could do as much to make technical conferences technically efficient as Mrs. Beeton's guide to good cooking did to ensure the majority of British working husbands during the second half of the 19th century came home to a reasonably appetising meal. It is not by any means the first and no doubt will not be the last publication on conference organisation, but its claim to review lies in that it is intended to appeal to technical conference organisers—not the few professional conference organisers, but the man who finds himself called upon by his colleagues to organise the *ad hoc* function.

Very wisely, the author, Mr. Herbert S. Kindler, does not set out to provide a blue print for the ideal conference or indeed a " package deal " for conferences of different types. Indeed Mr. Kindler admits there is no best type of conference. But if only half the recommendations which he makes were acted upon we should have fewer of the patently amateur efforts which the majority of industrialists who attend conferences (either by choice or direction) are forced to endure. To be fair, however, in very many instances the organisers are labouring under the handicap of insufficient funds, or insufficient time, or insufficient staff, or some other factor over which they have little or no direct control.

The author's many hints and directives for a successful conference can be gathered together under four basic, interdependent headings. These are: (1) making available worthwhile information (both new and review material); (2) effective presentation of conference information; (3) adequate facilities for discussion to enable acceptance, rejection, modification or amplification of the information presented; and (4) suitable environment (including layout and comfortable surroundings).

Not every conference organiser will agree with all the recommendations made by Mr. Kindler, while some of his suggestions would in very many instances be extremely difficult to apply. For example, he details a suggested agenda for the first meeting of the conference planning committee which he schedules to last from 9 a.m. to 4.30 p.m. How wonderful if it could ever materialise, but as any technical conference organiser knows only too well, half the committee members find they have another afternoon engagement (or at best a luncheon appointment which will mean their being very late in returning for the afternoon discussion), while another third will have been prevented from turning up anyway. Hence in the majority of instances the organiser is lucky if he can get his committee together in any real strength for as long as three hours on any one occasion. Without disagreeing with what Mr. Kindler would try to achieve at the all-day meeting, it is more feasible to think in terms of streamlining his approach to fall in with the commitments of the committee members.

That a committee (or working party) is necessary is unlikely to be disputed, but many British technical conference organisers will be rather taken aback by the sight of the elaborate conference organisation chart on page 17 of the book. Under the conference planning committee there are listed a conference advisory board, an evaluation committee, three coordinators (programme, finance and host), plus no fewer than 15 subcommittees. No doubt the author over-elaborated on the organisation side, but the duties of these subcommittees cannot be ignored if the successful conference is to materialise.

For example, many conferences have failed

because the organisers have not fully appreciated the level of audience at whom they were aiming. Selection of suitable papers, conference budgeting, programme scheduling, selection of chairmen and speakers, conference location, dates (no conference would ever take place if one allowed for every possible contingency, so the committee will have to choose between staging the conference on the same date as the chairman's wedding anniversary or the opening of a test match or international rugby match or the date when a conference on an allied technical subject has already been scheduled), documentation, promotion and public relations and supporting activities (ladies' tours, dinners, outside social events, and so on) must all be considered.

There is much solid advice on these and many other points and as they are supported by a conference budget check list the recommendations should help any organising committee to hit on a practicable fee which will give those attending value for money and ensure that the function at least pays its way.

What stands out very clearly is that however good the technical content matter may be, a successful conference can be completely marred if there is failure on one small point. Whereas conference delegates will shrug their shoulders and forget very quickly if Professor Blank gives a bad platform performance, they will remember for a very long time that a slide was inserted upside down in the projector, or that the microphone failed, or that the seats were uncomfortable or the ventilation bad. Timing, of course, is all important. In this country, at any rate, Monday afternoon (at the earliest) to Friday morning (at the latest) are the most successful conference periods. True some weekend conferences are well attended, but by and large they are not popular because of their interference with family commitments.

The requirements in respect of chairmen and speakers are discussed at some length. Mr. Kindler must have endured the embarrassment of watching many speakers overrun their allocated time, for he strongly recommends the use when necessary of a prearranged signal from the chairman to any speaker indicating that he needs to bring his talk to a conclusion without delay.

There is a complete chapter on promotion and public relations which is summed up by Mr. Kindler as follows: "The essence of successful public relations is having something important to say and saying it with sincerity and conviction. No amount of sincerity, introspection or surveying, however, will help unless a public relations' voice speaks in a language that can be clearly understood." It is unlikely that anybody will disagree with this point of view.

There is a lot more material, including a chapter on documentation (which can probably be described as the organising committee's biggest headache) in this very useful guide. It is up to any organising committee to accept or reject any of the principles and recommendations made (probably nobody would be more surprised than Mr. Kindler if they were all adopted at any one conference). What any organiser does at the risk of staging the greatest conference flop of all times, however, is to entirely ignore Mr. Kindler's recommendations.

V. M. GREEN

New Books

Fundamentals of Rocket Propulsion. By RAYMOND E. WIECH, JR., and ROBERT F. STRAUSS. *Reinhold, New York; Chapman and Hall, London.* (44*s*)

The history, fundamentals of operation, design of components and methods of application of the rocket engine, intended for the technical student, and for the non-specialist engineer.

Lloyds' Register of Shipping, Register Book 1960-61: Volume 1, Register of Ships; Volume 2, Appendix; Volume 3, Shipowners. *Lloyds' Register of Shipping.* (*Volume 1*: 360*s*; *Volume 2*: 80*s*; *Volume 3*: 40*s*)

Details of 87,029 ships from the S.S. A A Augustus to the steam trawler Zyguli. The appendix volume contains available particulars of structural details, capacities, etc., for ships other than tankers, tankers, ships carrying refrigerated cargo, and refrigerated cargo containers.

Elementary Engineering Mechanics. By EUGENE GEORGE KEY. *Wiley, New York and London.* (44*s*)

Professor Kay's book presupposes a knowledge of mathematics up to and including plane geometry and algebra, and an ability to learn and use algebra. It is designed specifically for a two year university course.

Naval Marine Engineering Practice, Volume 1. Admiralty Publication No. B.R. 3003(1). *HM Stationery Office.* (20*s*)

This book contains brief descriptions, and methods of operation, of typical machinery, boilers and systems for which the Ship Department, Marine Engineering Division, of the Admiralty is responsible, and supersedes BR77 *Machinery Handbook*.

From Galaxies to Man: A Story of the Beginnings of Things. By JOHN PFEIFFER. *Victor Gollancz.* (21*s*)

A popular account of the present state of thought and knowledge on the evolving universe, from matter through life to man, based on the century of research since the publication of *On the Origin of Species*.

Technology, Engineering and Safety. Volume 2. Edited by R. HURST, R. N. LYON and C. M. NICHOLLS. Progress in Nuclear Energy, Series 4. *Pergamon Press.* (105*s*)

The fourth in a series of eleven volumes of edited proceedings of the 2nd Geneva Conference, this covers reactor chemistry and materials, engineering experience and practice, and engineering aspects of reactor safety.

A Practical Manual of Industrial Finishes. By B. M. LETSKY. *Chapman and Hall.* (35*s*)

A short history of industrial finishes serves to introduce an account of the formulation of paint finishes for wood, metal and other surfaces, methods and equipment for their application, and the economics and organisation of the finishing department.

International Congress of Combustion Engines (CIMAC), 1959 Conference held at Wiesbaden. *Internationaler Verbrennungskraftmaschinen-Kongress (CIMAC), Brentanostrasse 29, Frankfurt/Main.* (120*DM*)

The subject of the Congress was "Diesel Engines and Gas Turbines up to 1,500 H.P.," and a total of 36 technical papers was presented by participants from nine different countries.

Science in Space. Chapter 2: The Nature of Gravitation. Chapter 3: The Earth. Chapter 4: The Moon. Chapter 5: The Planets. Chapter 7: Physics of Fields and Energetic Particles in Space. *National Academy of Sciences, 2101 Constitution Avenue, Washington 25, DC.* ($1 each)

The Space Science Board of the National Academy of Sciences has issued the first five chapters of a nine-part survey intended to review areas and opportunities for important research studies using space vehicles, and to suggest what now appear to be major areas of emphasis for the US national space effort.

Disposal of Radioactive Wastes. Volume 1. Proceedings of the Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 16-21 November, 1959. *International Atomic Energy Agency, Vienna; HM Stationery Office, London.* (36*s*)

Papers on the nature, treatment and processing of radioactive wastes, and the present methods used for their disposal, were presented by experts from 13 different countries.

Exploration in Management. By WILFRED BROWN. *Heinemann.* (30*s*)

The Glacier Metal Company has become a centre of pioneer studies in the social sciences, and in the present book the chairman gives an account of the organisational system which has gradually evolved in his company.

Thermochemistry for Steelmaking. By JOHN F. ELLIOTT and MOLLY GLEISER. Volume 1. *Addison-Wesley Publishing Company, Reading, Massachusetts; Pergamon Press, London.* (75*s*)

Sponsored by the American Iron and Steel Institute, this first volume contains information on the pertinent chemical properties and some physical properties of important elements and compounds.

Approved Methods for the Physical and Chemical Examination of Water. 3rd edition. *Institution of Water Engineers, Parliament Mansions, Abbey Orchard Street, London, SW1.* (10*s*)

The chief revisions or additions in this third edition include those sections dealing with the determination of nitrate, sulphate, sodium and potassium, aluminium, copper, lead, zinc, and synthetic anionic detergents.

A Glossary of the Diamond-Drilling Industry. By ALBERT E. LONG. Bureau of Mines Bulletin No. 583. *US Government Printing Office, Washington, DC; HM Stationery Office, London.* (3*s* 6*d*)

The scope of the glossary is confined to terms, letter names, and abbreviations commonly used in the diamond-drilling industry, primarily confined to the United States: a total of nearly 4,000 entries.

The Engineering Industries in Europe. *Organisation for European Economic Co-operation, Paris; HM Stationery Office, London.* (7*s* 6*d*)

The third statistical study of the OEEC Machinery Committee, covering statistics up to and including 1958.

The Reviewers

Mr. M. V. Callendar, M.A., M.I.E.E., M.T.S., is in charge of the television research section in the engineering department of E. K. Cole Limited.

Mr. G. E. Tewson, M.A., is a partner in the firm of O. W. Roskill Industrial Consultants.

Mr. H. F. Harrison is senior lecturer in instrument design and measurement in the Department of Production Technology and Control Engineering at Northampton College of Advanced Technology.

Mr. V. M. Green, who is a fellow of the Royal Statistical Society and a fellow of the Institute of Work Study, is head of the Projects Section, British Productivity Council.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant

Vibrating Screens. NIAGARA SCREENS AND PLANT LTD., Straysfield Road, Clay Hill, Enfield, Middlesex. Vibratory screens for collieries and other plant; fixed and portable types for dry coals or slurries. Illustrated folder.

Water Coolers. VISCO ENGINEERING LTD., Stafford Road, Croydon, Surrey. Evaporating water coolers, steel shell or other forms illustrated in brochure 603 which also contains hydraulic tables.

Cleaner. KERRY'S (ULTRASONICS) LTD., Warton Road, Stratford, London, E15. General purpose 500 watt ultrasonic cleaning plant for small parts; 1½ gallon tank. Folder gives all details.

Screens. ARMSTRONG WHITWORTH (METAL INDUSTRIES) LTD., Close Works, Gateshead upon Tyne 8. Overstrom vibrating screens for light, medium, or heavy duty on wet or dry materials. Single, double or triple deck models up to 5 ft by 12 ft. Constructional details and capacities in 8 page brochure.

Bag Filter. W. C. HOLMES & CO. LTD., P.O. BOX B7, Turnbridge, Huddersfield. Range of standard bag filters with shaker gear; capacities from 565 to 18,365 cu. ft per minute. Range and description given in publication 83.

Starch Dryer. ROSIN ENGINEERING CO. LTD., 14-17 St. Cross Street, Hatton Garden, London, EC1. Büttner rapid circulation dryers for starch giving improved conservation of by-products. Range of sizes from 2,310 to 22,700 lb per hour of wet material. Leaflet.

Magnetic Separator. RAPID MAGNETIC LTD., Lombard Street, Birmingham 12. Magnetised roll separators with up to four rolls and with or without scalper drum. Throughputs up to 1½ tons per hour. Folder.

Portable Conveyor. J. COLLIS AND SONS LTD., Regent Square, Gray's Inn Road, London, WC1. The Loadaveyor with either slats or belt; 4 or 2 wheel chassis types, adjustable elevation. Leaflet.

Screw Conveyors. LINK BELT CO., Prudential Plaza, Chicago 4, Illinois, USA. Screw conveyors and feeders of over 20 types, listed and illustrated in 76 page catalogue. No. 2989.

Marketing

Anglo-German Link In Heavy Engineering

AN ARRANGEMENT to collaborate in building hot and cold rolling mills, ferrous and non-ferrous, has been reached between the West German firm SCHLOEMANN AKTIENGESELLSHAFT and the WELLMAN SMITH OWEN ENGINEERING Corporation.

The negotiations were finally sealed in a visit to Dusseldorf by the Wellman chairman, Sir Peter Roberts.

The combined quality and experience of the Wellman concern and advanced designs in rolling mills of Schloemann will be applied to the markets of Great Britain and the Commonwealth.

Two years ago, at the Corby Works of STEWARTS AND LLOYDS, the present agreement was foreshadowed in that the 48 in blooming mill then installed was Schloemann designed and Wellman built.

BMC Cars From Italian Factory

INNOCENTI, of Italy, are now producing two of the BRITISH MOTOR CORPORATION's range of cars. They are the Austin A40 saloon and the countryman model, slightly modified to comply with recent Italian road regulations.

The big, highly diversified Italian concern built in eleven months a new car plant of almost 400,000 sq. ft. It will eventually reach an output of more than 50,000 vehicles a year. Innocenti have appointed dealers up and down Italy and have supervised the training of mechanics and the building up of the sales and service organisation.

Selling at 880,000 lire, about £500, the A40 has a lower price than any comparable model now selling in Italy. The countryman costs the equivalent of £530.

Innocenti is one of Italy's largest concerns. It produces the Lambretta scooter, heavy equipment for the steel industry, pipes and tubing and machine tools. This agreement with Innocenti means that BMC have followed the FORD line in making their own independent excursion into the European Common Market.

Hawker Sales Agreement On Forage Harvesters

The INTERNATIONAL HARVESTER Company are to undertake the future marketing of Forage Harvesters, made by GLOSTER EQUIPMENT Limited, a subsidiary of the HAWKER SIDDELEY Group.

The International Harvester distribution system is world wide. In the words of the Hawker chairman, Sir Roy Dobson: "They have a distinguished reputation in agriculture and sales connection in every part of the world."

The machine will now be known as the McCormick International Gloster Forage Harvester. Among the attachments for the machine is one, a kale device, which has won a silver medal award of the Royal Agricultural Society of England.

BAMFORDS, of Uttoxeter, Staffordshire, who formerly marketed the machine will still make available through their dealers spare parts for machines already sold by them.

Leyland Repeat Orders From US Haulage Firms

With 66 per cent of their vehicle delivery in September going to overseas operators LEYLAND MOTORS, the Lancashire heavy truck group, are watching with interest as the performance of their first medium-weight diesel trucks in the United States earns repeat orders.

Leyland first sent a fleet of Scottish built diesel trucks to North America and the repeat orders are now coming back from operators of large truck fleets—key people in furthering the expansion of Leyland sales in the potentially enormous US field.

A useful example is that of a 95 h.p. Chieftain truck, bought by the HERTZ CORPORATION, and working under contract for the SEASONMASTER Company. The vehicle gave an average fuel consumption of 11·95 miles to the US gallon on its maiden run over 600 miles in undulating country. Fitted with an aluminium van body it took a 15,000 lb payload of aluminium storm window and door fittings from Jamaica, Long Island through New England stopping at various cities and suburbs. On many runs it is now known that the miles per gallon return was as high as thirteen.

The Hertz Corporation has recently bought another two Chieftains. The buyer of a Clydesdale 105 h.p., who has used it mainly to carry loads of paper bags around one of the biggest of all the American supermarket chains, has now contracted for another five.

Turning aside for a moment from the export prowess of the group, a 22 year old Leyland trolleybus has been given by London Transport to a museum in Paris. The vehicle was one used in 1938 for a tram conversion scheme.

An Independant Commercial Computer Centre for London

Following the announcement that the big independent research and computer services firm, C-E-I-R, of America, was making an IBM 7090 computer available to commerce and industry in New York, comes the information that the English subsidiary, C-E-I-R (UK), is to open a London computer centre next May.

The IBM 7090 and IBM 1401 computers to be installed in the London Research Centre will be available to any firm or organisation that wishes to "buy time" on them. The operating company is independent of any computer manufacturer.

Dr. C. Oswald George, the vice-chairman of the English company, has said that while the centre will be able to provide computer services to firms both large and medium sized, and to some smaller businesses, he expects that at first some of the best customers will be companies who already have their own computers installed.

US Tyre Valve Plant To Open in Ulster

United States companies have done a great deal in attacking the difficult economic problems of Northern Ireland by setting up subsidiaries among the Six Counties. The comments of their senior executives on the ready ability of the Ulstermen (and women) to be trained, and the freedom from labour troubles suggest that other US business chiefs will get to know of the advantages and move in.

Mr. Austin R. Zender, president and chief executive officer of the BRIDGEPORT BRASS Company, of America, gave his reasons for deciding to set up in Northern Ireland when he signed the agreement with the Northern Ireland Minister of Commerce, Lord Glentoran, in New York.

Mr. Zender said, "Our decision to operate a plant in Northern Ireland for the manufacture of tyre valves was made after an extensive tour of many other European locations. Northern Ireland's proximity to the expanding European automotive market, which this tyre valve plant will serve, enhances its position as a location for an operation of this kind."

The new factory will be at Lisburn where there are good transport facilities and a ready supply of men and women with various skills.

The Bridgeport president specifically noted the cooperative spirit and enthusiastic support given to the company by the government officials of Northern Ireland.

UK and West German Contact on Trade Talks

Quietly behind the scenes, the British and West German authorities are keeping in close touch on the question of a meeting to be held in parallel with any meeting of the European Common Nations that may be held in Paris at the time of the Nato meeting in December.

The chief Government spokesman in West Germany has said that there are definite indications that a meeting of the Six will take place while the Nato conference is in session.

If, as seems probable, Mr. Macmillan finds himself meeting Dr. Adenauer on economic problems towards the end of the year, it will be with the knowledge that while progress at Government level appears to have been nil, increasing numbers of United Kingdom companies have arranged their own subsidiaries, or licence arrangements on the Continent.

London Transport Replacing Half of Rolling Stock

At a cost of over £30 million LONDON TRANSPORT EXECUTIVE has on order or in process of delivery almost 1,700 Underground cars. This substantial total, equal to the replacement of half the present rolling stock was reached with the recent order for 619 cars of 1959 Tube stock. Among the 1,700 new cars are 246 District Line R stock and 91 Tube stock cars delivered since 1950.

This wholesale replacement of the LTE's rolling stock is part of the modernisation scheme, another element in which is the four-track and electrification work on the Metropolitan Line.

The 1959 (silver) Tube stock, which has 1,280 cars on order, is for use on the Central and Piccadilly Lines, replacing almost all that are now in use on the Central Line and all but the newest stock on the Piccadilly.

METROPOLITAN-CAMMELL CARRIAGE AND WAGON are building 589 of these cars, BIRMINGHAM RAILWAY CARRIAGE AND WAGON—450 and the Derby Works of the BRITISH RAILWAYS, Midland Region are constructing 169.

All these cars should be in service by the end of 1963 making improved travelling conditions possible on both lines.

The Central line will eventually be equipped with three trains of a new type to be made up of four new driving motor cars built by CRAVENS Limited. These will each have four trailer cars modernised at London Transport's works at Acton.

Orders for the Metropolitan line were placed last March with Cravens for 248 cars of a new design worked out to cope with the varying traffic demands of the line. With their unpainted light weight aluminium bodies these cars should all be delivered by the time the four track work between Harrow and Watford is complete in 1962. A later order, for 216 cars from Cravens, was given in June to replace all the rolling stock in use on the Metropolican line to Uxbridge.

Private Industry Moving Out Into Space

The official request to the United States Government from the AMERICAN TELEPHONE AND TELEGRAPH Company to be allowed to put a telecommunication satellite into orbit around the earth is the first formal step by a private firm into taking a commercial return from space.

If the US Government gives its permission there may be a particularly fascinating calculation to be made. It would presumably be necessary for the ATTC to purchase one, or several, launching vehicles, and to obtain the use of launching facilities and staff. Just how much such costs should reflect a part of the multi-million dollar expenditure that has poured into rocketry and space research every month for years can hardly be clear. Probably no such attempt could be made and still leave the company's project commercial.

The equipment which apparently it is planned to be put into orbit is not the most advanced that is being currently developed. But simply to have a communication satellite operating for about 35 minutes three or four times every day would make not only a contribution to technological history but a useful contribution to the world's communication systems.

Fifty New Cables?

The BELL TELEPHONE Company have shown in recent calculations that international telephone calls from the United States, now about three million a year, may reach one hundred million twenty years from now. This would need another 50 present style trans-Atlantic cables.

Investigations carried out in Britain by HAWKER SIDDELEY AVIATION, PYE and others suggest that a British system could be established which would carry a heavier traffic at a cheaper cost for each minute of transmission.

But the best railway carriage in the world depends on motive power to take it somewhere. The lack of a British equivalent to the US Atlas missile may mean that step by step the American interests will get the next phase of international communications equipment into orbit while a technically superior British system rests on the ground.

Colchester 'Chipmaster' Centre Lathe

The basic engineering production tool is the subject of this first Product Profile. These new studies of outstanding products will appear every week in ENGINEERING.

THE CHIPMASTER is a lathe with a strong character. It was designed with an eye to the future, having features that would fall in step with what seemed to be the most significant trends in machining and in machine tool operation. And like the rest of the Colchester family, it was designed to take advantage of that seldom-admitted facility of engineering—combining low cost with high quality in one and the same machine.

Centre lathes are basic to engineering. Inevitably, a machine with such a long history develops slowly. Yet the designers of the Chipmaster foresaw changes in users' requirements and they were determined to be ready with a lathe that would meet those requirements when the time came.

In 1955-56, when the prototype was being prepared, the following trends were discerned by the management of the Colchester Lathe Company Limited:—

(1) The miniaturisation of many components in various branches of engineering would create a requirement for a centre lathe that would handle such components economically;

(2) the use of materials which could be machined at high speeds would grow;

(3) high-speed steel tools would increasingly give way to cemented carbides, and they, in turn, to ceramics;

(4) the advantages of constant cutting speed would come to be recognised.

This was the world into which the Chipmaster was to be born, and its character was conditioned accordingly. It is a medium-small centre lathe, capable of high and infinitely variable speeds, with high power for a machine tool of its size. It is a high precision machine, but at the same time rationalisation of design and manufacture have kept its cost low.

When the present managing director, Mr. A. J. Hayward, joined the company in 1948, it was still generally accepted that machine tools had to be made by traditional methods. Hand scraping was the symbolic ritual.

FRESH VIEW

Mr. Hayward argued that mass production to fine limits could as easily be applied to machine tools as it had been to motor cars. He had the advantage that he was a newcomer to the machine tool industry—he had previously been with Wellworthy Limited, the piston ring makers—and he was thus equipped to take a fresh, objective view of the problems. His argument depended, of course, on the company being able to sell lathes in large numbers. That is exactly what they have achieved in the last ten or twelve years. A visitor to their works is left with the strong impression that this single-minded concentration on centre lathes and accessories has been an indispensable condition of their success. A policy of diversification, now so widely accepted as desirable in industry, would not have been appropriate, although the overall benefits of diversification were realised when the company joined the 600 Group in 1956.

Colchester the town is about 50 miles from London, in the county of Essex. It is a predominantly agricultural area, with little or no tradition of the engineering skills normally associated with machine tools. In such an area, however, it has been possible to build up a nucleus of skilled men who, with a larger number of semi-skilled workers, provide the kind of production team required. A total staff and labour force of about 650 turn out 3,500 lathes a year, and the output is increasing. By spreading the overheads over such a large number of machines, the cost of each lathe is brought down appreciably below that of comparable lathes produced by traditional methods. At £621 the standard Chipmaster is considerably cheaper than other machines of comparable performance. The company which produced about 12 lathes a week immediately after the war now runs the largest works in Europe solely devoted to the production of centre lathes.

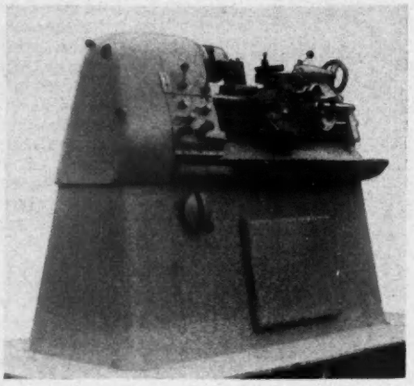


Fig. 1 Wooden mock-up for the prototype.

Five models of lathe, of which the Chipmaster is one, are made at the works. The most successful of the five so far has been the "Student" lathe, which was introduced several years before the Chipmaster and is more conventional in design. It is now possible that the Chipmaster will gradually overhaul it in sales, but that will depend on the extent to which lathe users decide they want the modern machining features which have been incorporated in the Chipmaster.

A combination of sound commercial sense and lively engineering rather than high-powered research have been responsible for the design and development of the Chipmaster.

From the original conception of such a lathe to full production and marketing takes from two to three years, and this period is divided into a number of stages. An important step is the making of a wooden mock-up to check the layout of the controls and the styling (Fig. 1). That the original concept was right is evident from the fact that no fundamental alterations have been made since the machine was introduced at the 1956 Machine Tool Exhibition.

BASIC FORM

The basic form of the machine represents a departure from the conventional in that the bed and base combine to form a pyramid. This shape was adopted because of the increased cutting loads which were envisaged with carbide and ceramic tools. The bed (Fig. 6) has three ported openings running from the top between the slideways, down at an angle to the rear. This arrangement is designed to carry away most of the chips and coolant to the rear of the lathe, leaving the operating position clean and free from swarf. The cabinet base on which the bed is mounted is an unusually large die casting. The complete lathe stands on the floor on three simple rubber feet to avoid the necessity of levelling.

A 5 in by 20 in high-speed precision lathe is a brief specification of the Chipmaster. The centres are in fact 5⅛ in high, so the lathe swings

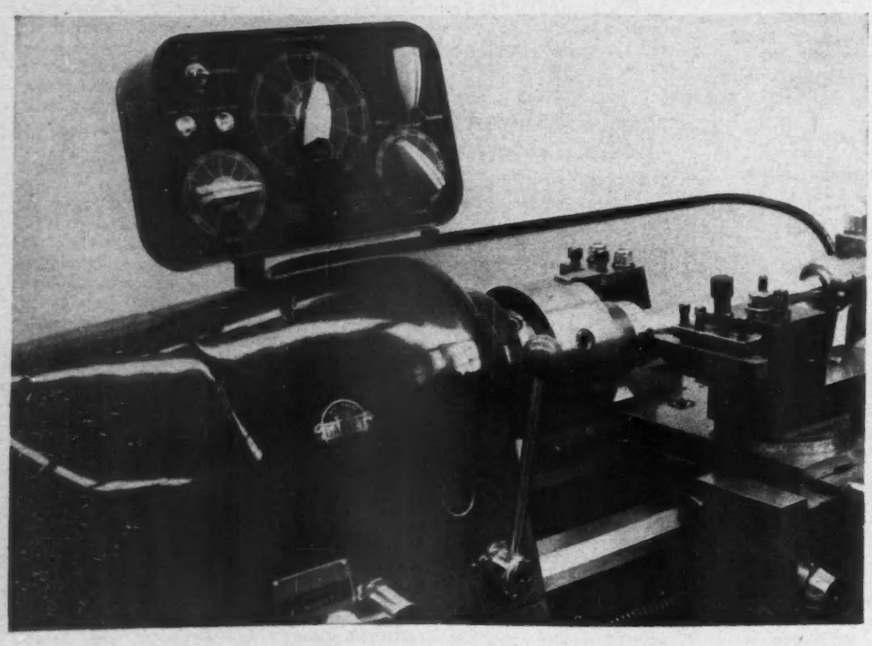


Fig. 2 Latest development: constant cutting speed.

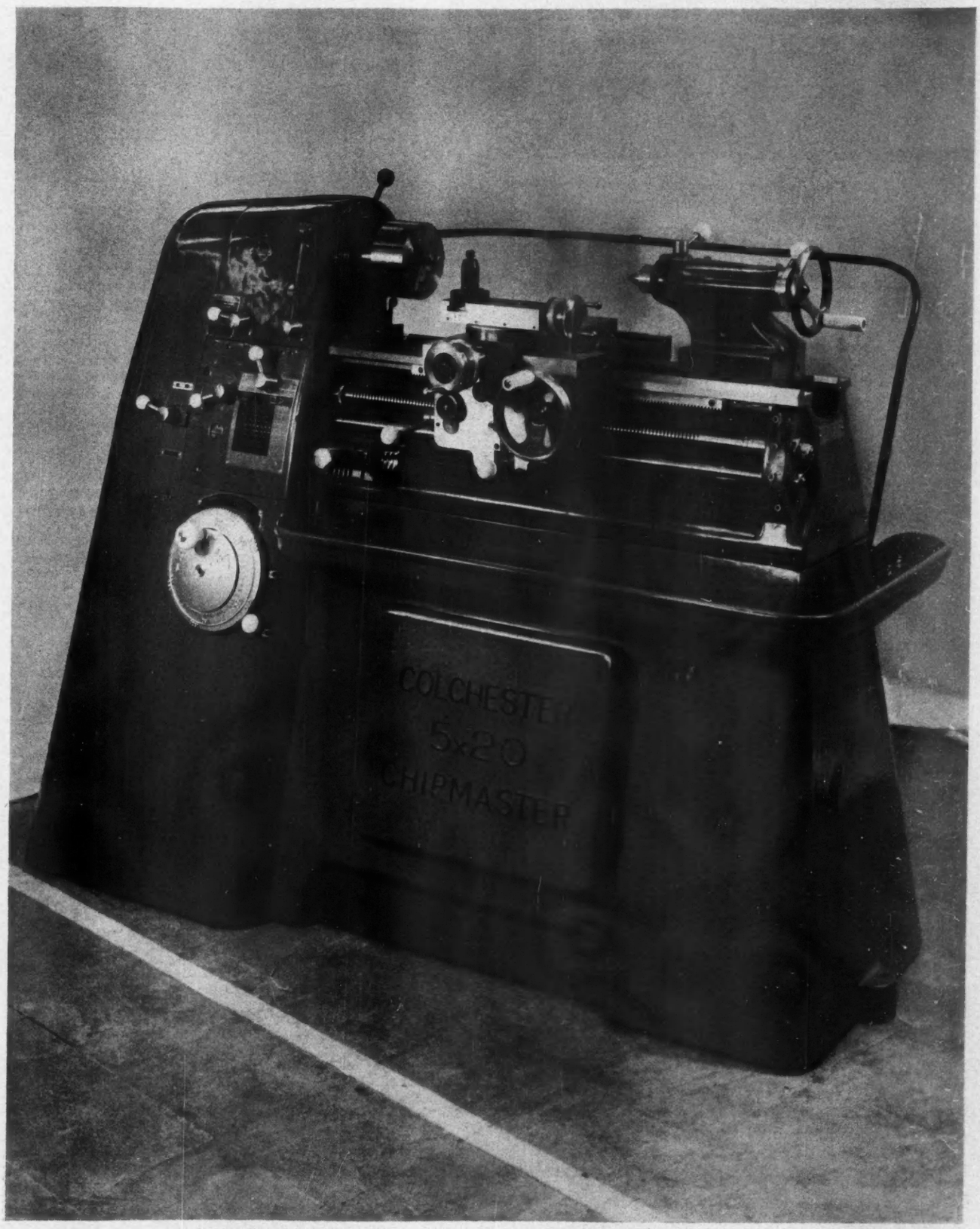


Fig. 3 This is the lathe that was built to suit the changing needs of a growing market.

Fig. 4 Talysurf record of surface finish in turning.

Fig. 5 (right) Talyrond record of roundness in turning.

11¼ in diameter over the bed. The swing over the carriage is 7 in.

The headstock spindle runs on Gamet precision taper roller bearings. These bearings are of French origin, and are now made in Colchester by an associate company within the 600 Group. Their design provides accuracy with rigidity, coupled with minimum friction and low temperature rise even at the highest speeds. The rollers are hollow and most of the circulating oil is passed through the holes in the rollers, thereby helping to cool the bearing. The remainder of the oil is metered to the running surfaces of the rollers and rings by a cage of special design. Thus by controlling the amount of oil which passes to the running surfaces, excessive churning of the oil and consequent increase in temperature are avoided.

The variable-speed drive to the headstock is a feature of the Chipmaster which could not have been built into such a lathe appreciably earlier because of the lack of suitable variable-speed units. The Kopp variator, which is used in this lathe, is manufactured by Allspeeds Limited, and the difficulties associated with variable-speed drives in engineering generally were overcome in the Chipmaster application.

Up to 300 r.p.m. spindle speed, the drive is through gears. The majority of machining operations require a higher speed, however, and up to 3,000 r.p.m., which is the present top speed of the lathe, the drive is through toothed rubber timing belts (Fig. 7), and all gearing in the headstock and gearbox is disconnected. These belt drives account in part for the remarkable degree of machining accuracy which can be achieved on the lathe.

CONSTANT SPEED

For the operator, infinitely variable speeds are convenient chiefly because he can change the speed while the lathe is cutting. This feature has been on the Chipmaster since it was introduced in 1956, but a later development introduced earlier this year provides constant cutting speed, the controls for which are mounted on a special panel above the headstock (Fig. 2). By setting a dial marked "Constant" to a selected cutting speed, the operator ensures that as the tool moves across the work towards the centre line, the workpiece speeds up so as to give the constant cutting speed. By this means the lathe is used with the utmost effect and floor-to-floor times are reduced. A further advantage is that tool life is longer as the tool is working at the optimum speed during the whole of the machining operation.

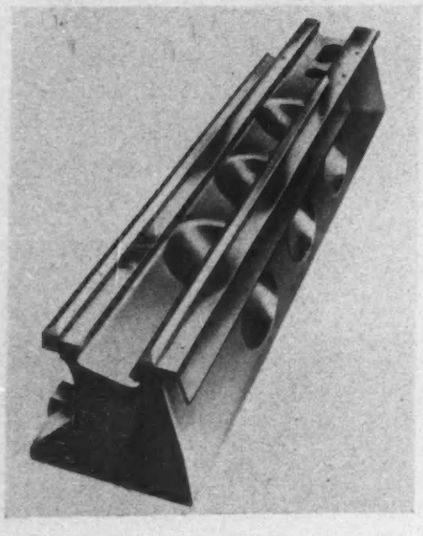


Fig. 6 Re-thinking in bed design.

ACCURACY

In the development of the Chipmaster an important aim has been to increase machining accuracy. The standard Chipmaster is guaranteed to turn round within 0·0001 in, but the company's research and development department has achieved exceptionally high degrees of accuracy using diamond tooling. As Figs. 4 and 5 show, a roundness accurate to within 10 millionths of an inch has been obtained, with a surface finish and straightness each of 1 micro-inch. This order of accuracy is not normally offered in a Chipmaster, but such studies help the company to improve and generally develop their products.

The Chipmaster has not yet reached the scale of production that the Student lathe has achieved, but as much advantage as possible is taken of the production system of jigs, fixtures, and gauging which is characteristic of the Colchester works. The production shops make use of multi-spindle and single-spindle bar automatics, profile automatics, semi-automatics, programmed milling, and other plant of this nature. Thread rolling is used for the production of many of the operating screws; bed grinding is done by means of a specially designed multi-spindle machine which grinds all seven surfaces of a bed at one time. A special multi-spindle fine boring machine is set up permanently to suit each headstock that the company make, even though the machine may only be used for a comparatively small part of the working week. The latest improvement to the production shops is the building of a special workshop for headstock sub-assembly. This shop will be air-conditioned and is being faced with light coloured tiles on the walls. The set-up is fully conveyorised with assembly stations at various points along the line.

SALES ABROAD

The unit construction principle employed in Colchester lathes ensures complete interchangeability of components. This feature has had a great bearing on the success with which the company sells its lathes abroad, since the problems of repair and replacement have thus been largely overcome. Even when an improvement is incorporated in the design of a later model, every effort is made to ensure that the new components will also fit the earlier lathes.

The company regularly exports to 55 overseas countries. The United States is an important market; but because American industry is more highly automated, the use of centre lathes is lower per 1,000 of population than in the United Kingdom, which means that there is no volume production of centre lathes. As a result, Colchester machines are extremely competitive with their American counterparts.

At the other end of the scale, the newly industrialised nations will go through the stage of using a large number of centre lathes for many years to come, so that the future of the company seems to be assured.

An essential condition of success is that the design of a lathe of this type must be suited to the requirements of the majority of users, and at the same time lend itself to quantity production. That is not an easy condition to satisfy. The success of Colchester lathes in the past decade is beyond question. It is only now, however, that the Chipmaster is coming into its own. In a sense it was ahead of its time, for even in this country perhaps as much as 50 per cent of machining is still carried out with high-speed steel tools. But undoubtedly the market for a lathe such as a Chipmaster will grow.

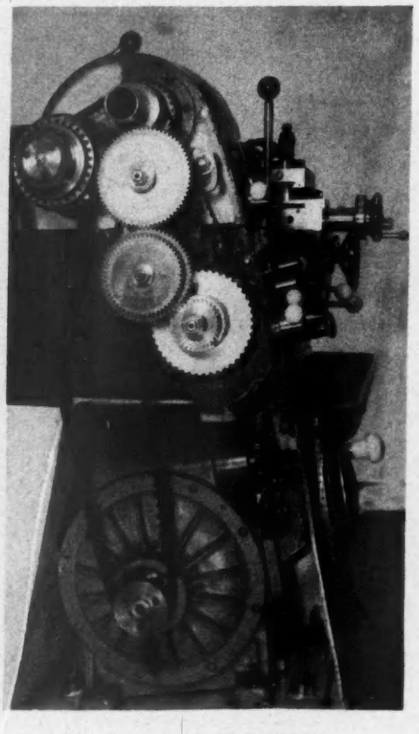


Fig. 7 Drive to the headstock.

Order Department Becomes 3,000 Buttons

Telephoned orders at an oil sales depot are recorded by pushing buttons. Sales tickets and invoices are produced automatically. Transactions are recorded on punched tape for computing accountancy and statistical information.

THE place where an automatic data processing system shows its individuality is at its input. In clerical applications, particularly, it is the input end that poses the special problems. The difficulty arises because computing systems generally take in their facts and figures by way of punched cards or tape, or magnetic tape, whereas clerks in such systems could receive their input by way of the telephone or a variety of written documents. Various answers have been produced to meet this problem: special reading machines have been developed, cash registers and typewriters have been fitted with tape punches, documents have been written in special inks or typefaces. Recently, another solution has been produced, and while the input system in this case is highly specialised—suitable only for one office in a particular organisation—its general principle could find very wide application. The installation referred to is the experimental equipment, called DORIS, at the Royston Depot of Shell-Mex and BP Limited.

About 85 per cent of the company's customers telephone their orders to the depots. The depot makes up sales tickets and delivers the products. Completed sales tickets, sales summaries and stock reports are sent to one of ten divisional offices. At divisions, punched cards are used for sales analysis and for book-keeping machines for customer's accounts. Invoices are typed.

Each year the result of this procedure is that the depots make out more than 3 million sales tickets, which lead to over 5 million punched

Fig. 1 The sales clerk wears a telephone headset. He can record an order in about 4 seconds.

cards and 1¼ million invoices. With the prospect of further trade expansion, the possibility of mechanising the clerical work at depots was investigated. One of the main objectives was to create error-free data in a form suitable for later machine processing. Mechanisation was found to be possible, but required special machinery. An investigation into ways and means was carried out in conjunction with Creed and Company Limited.

It was found that speed of processing would be adequate if electro-mechanical rather than electronic methods were used, and maintenance and staffing problems would be greatly simplified. Laboratory models showed the ideas thought out for the equipment to be feasible and the prototype equipment was then built—the equipment that has been christened DORIS (Direct Order Recording and Invoicing System). From start to finish the task of investigation and building took just over two years. By July, 1960, the prototype equipment was able to handle orders.

The installation has been designed for operation by a sales clerk receiving orders by telephone. He sits at the input console wearing a telephone headset. In fact, the console is a seven sided cubicle. On its walls are seven panels of push buttons, all within easy reach and each button bearing the name and address of a customer.

There are some 3,000 button positions, and this is the number of customers that could be dealt with. In fact, about 1,500 buttons are in use at present at Royston. The customers' names are arranged in alphabetical order. As

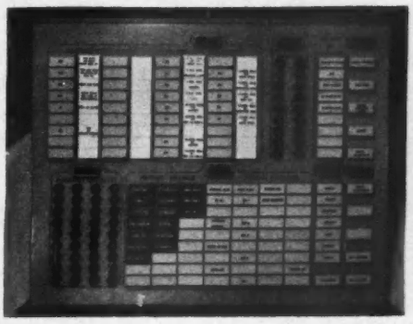


Fig. 2 All basic facts about the order are recorded on this panel.

soon as a customer announces his name over the telephone, the sales clerk depresses the button bearing that name.

Immediately in front of the sales clerk is a smaller panel by means of which he can record all the facts about the order as quickly as the customer gives them. On the left of the panel, under the words "Product Quantity," a series of numeral buttons records any quantity from 1 to 9,999 gallons. In the centre, under the words "Product Brands," is a series of buttons labelled with the names of products. These are colour coded for quick identification, red for Shell, green for BP. On the right, a row of buttons shows the day of delivery; and on the top of the panel other buttons cope with the packing code for deliveries in bulk and deliveries in returnable packages, including the number of such packages and the method of delivery.

While the buttons are depressed the clerk checks the order back over the telephone with the customer. He then pushes the "Transaction" button and the "End of Order" button. The function of the "Transaction" button is to enable the clerk to record an order for several products without re-entering the constant-factor buttons, such as customer and day of delivery. The "End of Order" button clears the input console ready to receive the next order.

If the clerk should neglect to insert any necessary piece of information, a buzzer sounds and one of the red panels (which appear as black oblongs in the picture) lights up and shows what has been omitted—for example, "Insert day of delivery." When special instructions about delivery are given, the clerk makes a note of the request on a scribbling pad and presses the "Special Instruction" button. This causes an asterisk to appear on the delivery ticket, which shows the routing clerk when he gets it that there is a special delivery instruction of which the sales clerk has a note.

The "End of Order" button is the last manual operation required. DORIS then sets about producing sales tickets and invoices. All the information about the order, recorded by pressing the buttons, is perforated on paper tape. As this takes four seconds and the average telephone call takes 15 sec, there can be no delay in handling orders. Subsequent processes, however, are slower than the initial recording time and a magazine is provided under the console table to hold the overflow tape.

The tape is read automatically and production of the issue document begins. The first step is to obtain full information about the customer and product. This is stored on reels of seven-channel strengthened paper tape. Five channels are used for normal letters and numbers, as on ordinary teleprinter tape, the sixth for machine control codes, and the seventh for customer identification.

For convenience of handling amendments and speed of processing, each customer's information has been split into static-address details and terms of trade details. These are stored on separate reels, 500 per reel. At Royston, with 1,300 customers, there are three reels holding addresses and three reels holding terms of trade. One reel suffices for the product details.

When the input reader mechanism identifies the customer number, the customer-information reels are revolved at high speed—the tape moves at 45 ft per sec—and the seventh channel holes are counted by a photo-electric cell until the required customer information is reached. The reels are then stopped and printing of the sales ticket begins. When the input reader identifies the product required, the product details are selected similarly from the product store reel. The description and price of the product are printed on the sales ticket, and the value of the total order worked out. Sales tickets and invoices are printed simultaneously.

At the same time as the sales ticket and the invoice record are being printed, therefore, the information required for summarisation of the day's transactions at the depot is punched on a further reel of perforated tape. To assist identification, the serial number of the sales ticket is automatically over-printed on the tape.

When delivery has been made, the tape is fed into the summariser, which has several functions to perform. It adds up the daily issues for each product. In addition, it sorts out the sales ticket information into punched card sequence and produces the information in this sequence for another punched tape. Thus during the day it is producing punched tape containing details of each order, and at the end of the day a printed record of the daily issues together with a

Fig. 3 Records of customer's addresses and terms of trade, and details of products, are stored on reels of perforated tape.

punched tape record both in punched card form and in an abbreviated form from which stock summaries are prepared. The detail and summary tapes, together with the printed daily summary of issues and values, are sent to the divisional office. Here the tapes are fed into a tape-to-card converter and the cards produced are available for use in existing Hollerith machinery. The cards or tape can then be processed by mechanical or electronic computers. The input stage is over.

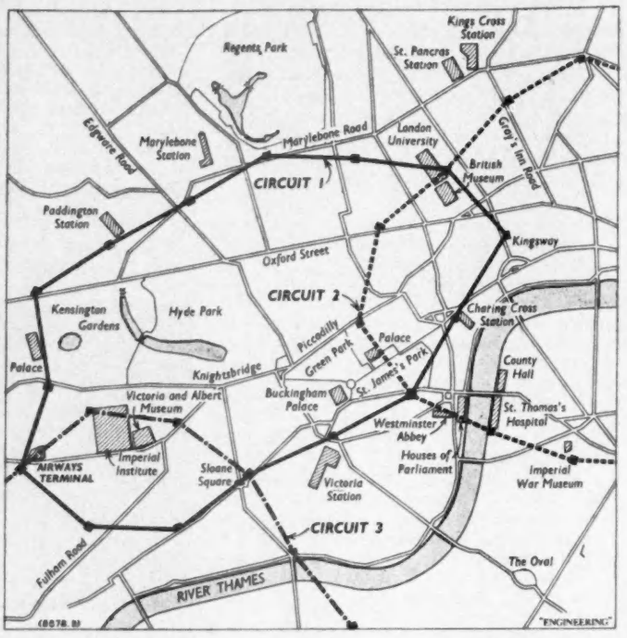
Could Travel in London be Quicker by Cable Car?

A proposal to reduce traffic congestion in central London by taking buses off the streets is put forward in the July-September issue of *International Ropeway Review*. The editor, Mr. H. F. Shields, suggests that cars travelling on overhead cables should be used instead. The trestles supporting the cables would be combined with a tall building having some other utility in the city —possibly a multiple-storey car park. In the final arrangement all buildings for this purpose would be spaced equally apart and would form the corners of a polygon. Loading and unloading stations would be installed in each trestle building and the cars would be spaced on the hauling rope at the same spacing as the loading stations. Thus displacement of the hauling rope by a distance equal to the distance between stations would cause all the cars to move one station round.

Stations would be spaced about 800 yards apart and movement of one car from one station to the next would take 3·3 min, including 0·6 min boarding time. Four parallel circuits to a polygon are envisaged; a car would leave a station every 50 sec. Car capacity would be 80 passengers.

The system would operate almost silently, and would not be affected by fog. Compared with buses, the need for a separate engine and gearbox in each vehicle is eliminated, and no driver would be required. Compared with underground railways, no signalling is required and installation costs are likely to be considerably cheaper.

In deciding whether such a system is desirable, a number of factors have to be borne in mind. The first circuit shown on the proposed layout serves points that are already adequately served by the underground railway. But the growing office population in central London is already overloading the stations of the underground system at peak hours. If this trend continues either considerable work will have to be carried out at the stations or the excess load must be carried by other forms of transport. Whether overhead cable cars can compete for this excess depends on future traffic policy in London. If private vehicle traffic is severely restricted and buses are able to move about more freely, their greater flexibility of operation will give them the advantages over the cableway. But if congestion gets much worse than its present level then the cable system could offer quicker travel. It would certainly be a very enjoyable way of travelling.



The proposed cable car route for Central London would be around a polygon, with equispaced stations. All cars on one circuit would be attached to the same hauling cable eliminating the cost and complexity of signalling.

Flywheel plus Diesel Prevents Interruption of Power

One of the largest "no-break" generating sets in the world was commissioned in Norway this year. It ensures continuity of electrical supply to navigational and telecommunication services. The prime mover is the Paxman 8RPH diesel engine manufactured by Davey, Paxman and Company Limited, Colchester, having a BS site rating of 366 b.h.p. at 1,500 r.p.m.

The driven machinery comprises a 200 kW 220/127 V, 3 phase, 50 c/s alternator, flexibly coupled to an asynchronous motor, which is in turn flexibly coupled to a heavy flywheel attached to a shaft supported by taper roller bearing pedestals. Connection or disconnection between the engine and the driven units is effected through an electrical induction clutch coupling, which is energised from the engine starter batteries. A pedestal bearing supports the weight of the coupling, the drive from the engine being taken to the induction coupling through a flexible rubber coupling intended to eliminate axial forces. The whole assembly is mounted on a substantial baseplate of fabricated steel.

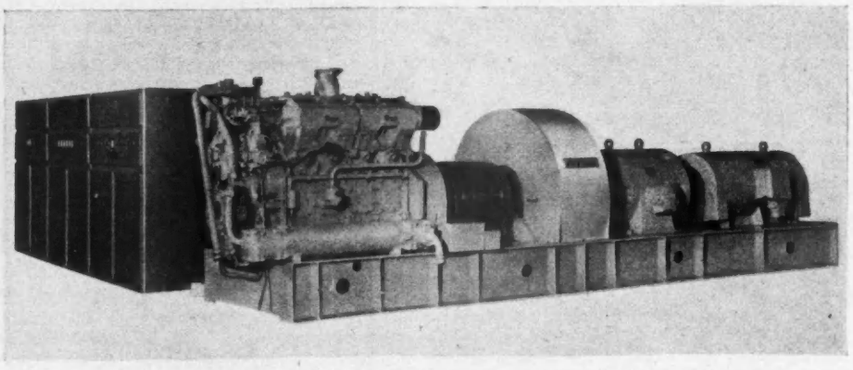
The alternator provides power for a group of circuits requiring uninterrupted supply. In the "mains healthy" condition, the mains power drives the alternator and the flywheel by way of the asynchronous motor. Under these circumstances the engine is stopped and the inductive coupling is not energised.

In the event of mains voltage or frequency falling below a stipulated level, or a complete failure of mains supply, the induction coupling is automatically energised to engage, thus causing the inertia of the rotating flywheel to turn the engine shaft. At the same time the engine starter motor is energised to engage and the engine fires. During the transitional period while the engine is accelerating to full speed, the output frequency is maintained to within 4 per cent of the normal 50 c/s by the stored energy of the flywheel, and the output voltage remains within 10 to 12 per cent of its nominal value. On restoration of mains supply, the electric motor again takes up the drive and the induction coupling is automatically de-energised, allowing the engine to be stopped.

The overall dimensions of the complete set are 22 ft 3 in long, 6 ft 3 in wide and 6 ft 6 in high. The flywheel is of cast steel statically and dynamically balanced, and weighs 5·8 tons.

A panel carrying the automatic starting, control and distribution gear is provided, together with equipment to give visual and audible indication of the operation of safety features fitted to the engine. These include safety devices for low oil pressure, high oil temperature, high water temperature, low water pressure, overspeed and underspeed. Jacket water is cooled through a remote-mounted radiator, and the oil cooler uses cooling water from the engine jacket cooling circuit. Jacket water temperatures are regulated by thermostats, and thermostatically controlled immersion heaters are fitted to the engine water jackets and lubricating oil sump.

When the engine is not running, the engine lubrication system is periodically primed through the medium of an electrically-driven pump which operates automatically on a time-cycle basis. Push button control is provided to enable the pump to be operated independently, when desired, for evacuating lubricating oil from the engine sump for an oil change.



200 kW generating set and flywheel for maintaining supplies to navigation and telecommunications equipment in the event of a mains supply failure.

Steam Sampling in Russia

Sampling of steam in boilers can be difficult and the results are often in doubt. Research on this topic has been carried out in the Soviet Union.

By J. Jackson

ICI Limited

IT IS often necessary to measure the purity of the steam leaving a boiler, both before and after it leaves the superheater, since this will indicate whether deposition is taking place in this part of the system. For this purpose, of course, it is necessary to sample the steam, and to ensure that the sample obtained is representative. The steam before it enters the superheater contains entrained boiler water, but sampling would present no difficulty if it could be assumed that the droplets of boiler water were uniformly distributed over the cross-section of the steam main. There is abundant evidence, however, that this is not the case. On the contrary, the bulk of the water present is in the form of a film on pipe-wall.[1–3]

Because of this, the sampling of wet steam presents a problem, since it is clear that a representative sample cannot be obtained either with the single or multi-port sampling nozzles now recommended by the ASTM[4] and ASME.[5] Greatest consideration of the problem seems to have been given in the Soviet Union, where two special sampling devices have been developed.[2, 6] These are both based on the fact that, above a certain critical steam velocity, the film of liquid water is torn off the wall of the pipe and uniformly redistributed over its cross-section. The critical velocity is said to have been calculated originally from an equation of Professor Ramzin,[6] the source of which, and the supporting data for which, cannot be traced. This is now less important, since according to Mozharov[7] the Ramzin equation was incorrect, and the true equation for the critical velocity is as follows:

$$v_{cr} = 115 \sqrt{\frac{\sigma}{\rho_s}} \left[\frac{x}{d(1-x)}\right]^{\frac{1}{4}}$$

where v_{cr} = critical steam velocity (m per sec); σ = surface tension; ρ_s = density of saturated steam (kg per cu. m; x = dryness fraction of steam; d = diameter of pipe in which steam flow is taking place.

The two Russian redistributing devices, the aim of which is to increase the steam velocity to a value some five times that of the critical, both take the form of constrictions of different shapes, as shown in Fig. 1, which are introduced into the steam main.

Since neither of these devices has been used in this country, there is no evidence on which to decide between them. They have been critically examined in the Soviet Union, however, by Mozharov and Panasenko.[8] These workers, in comparing the two devices, also took into account the direction of steam flow in the pipe, viz. ascending, descending or horizontal, a factor which does not seem to have been considered before in the Russian work on steam sampling. The tests were carried out on a special apparatus designed for the purpose by the MEI (Moscow Power Institute) and on a boiler of steam generation rate 25-32 tons per hr, pressure 45 atmospheres (abs.), and superheat of 475° C.

The results obtained by Mozharov and Panasenko with the BPK (Bureau for Once-through Boilers) Venturi constricting device are shown in Fig. 2 for the three flow arrangements. The results are plotted in terms of the ratio of S_s, the salt content of the steam in the sampling device, to S, the salt content of the bulk steam, against the ratio of v_s, the steam velocity at the entrance to the sampling device, to v, the steam velocity in the pipe. The most accurate results should be obtained, of course, for v_s/v equal to 1, i.e., for conditions of isokinetic sampling. As can be seen from Fig. 2, the BPK device gave good results only in horizontal flow.

Results plotted in the same way for the device of the TsKTI (Central Boiler and Turbine Institute) are shown in Fig. 3, which also gives results for a device originating from the VTI (All-Union Institute of Heat Technology), described below. The TsKTI device used in the tests was modified, as compared with that originally described,[8] by the replacement of the slot formerly used by a nozzle. As shown by Fig. 3, the best results were obtained with descending flow.

The VTI device mentioned above and shown in Fig. 4, consists simply of an ordinary small-diameter tube installed in the steam off-take at the point at which it leaves the drum. The idea behind this, of course, is to sample the steam before the film of water on the pipe wall has been able to form. This would seem obviously the most satisfactory way to sample wet steam. The results obtained are given in Fig. 3.

Curiously enough, exactly the same conclusion has been reached independently by Miskimen in the USA.[9] Miskimen, who was concerned with the sampling of evaporator vapour containing entrained droplets, also found, by using a traversing nozzle, that the entrained water was not uniformly dispersed in the off-take. He concluded, therefore, that the vapour samples would have to be taken where the spray droplets were uniformly dispersed, and that this condition existed only in the immediate neighbourhood of the point where the off-take left the evaporator shell. At this point, because of the uniform dispersion, only a single-port sampling nozzle was needed. The film of moisture on the pipe wall was already formed probably less than half a pipe diameter from the shell.

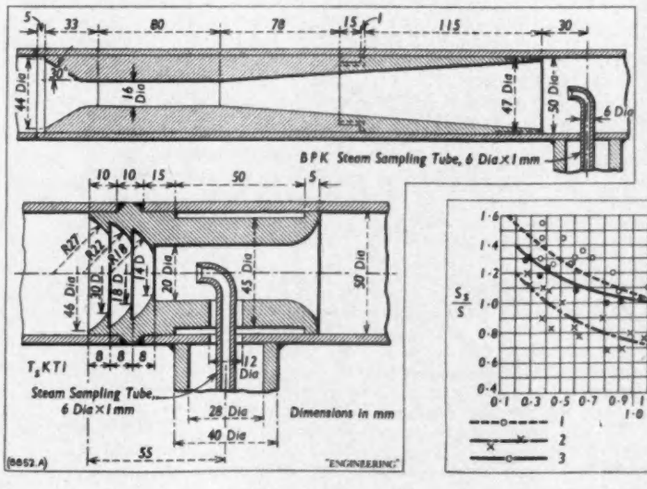


Fig. 1 (left) Two Russian redistributors.

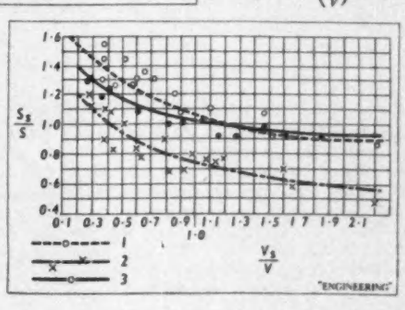


Fig. 2 (below) BPK mixer results; (1) ascending, (2) descending, (3) horizontal portion.

$$S = 1{\cdot}1 \left(\frac{v_s}{v}\right)^{\frac{1}{4}} S_s$$

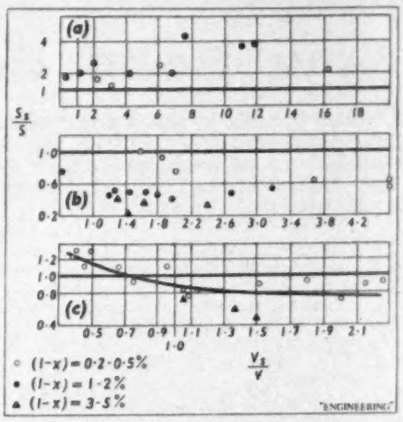


Fig. 3 Results of calibrating steam samplers; (1) TsKTI mixer in descending portion, (2) same in horizontal portion, (3) VTI device.

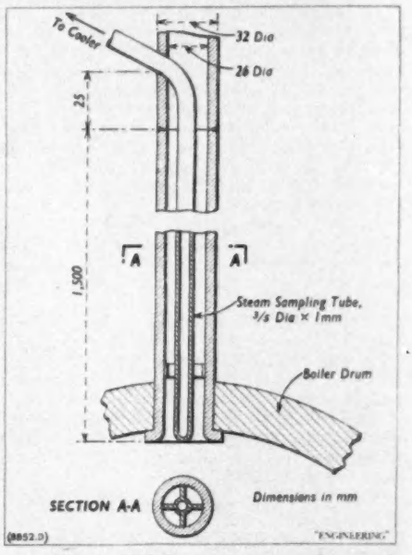


Fig. 4 VTI-Orgres steam sampler.

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New Road Research Track

One of the most advanced road research tracks in the world has been put into operation by the Department of Scientific and Industrial Research.

HIGHER speeds, ever-increasing traffic, and the special problems of motorways and other modern roadworks, are among the many factors which underline the need for large-scale practical road research facilities. To help in meeting this demand, a new road research track has been built at Crowthorne, Berkshire. By 1964, the site will also house the entire Road Research Laboratory of the DSIR—at present occupying two different centres, one at Harmondsworth, Middlesex, and the other, several miles away, at Langley, Buckinghamshire.

The importance and urgency of road research have been much emphasised and are widely taken for granted, but what is not appreciated is that such work can be financially profitable to the nation. In making his address at the official opening of the track last week, the Director of the Road Research Laboratory, Sir William Glanville, pointed out that: "In addition to the saving in human life that result from accident prevention, the sums saved annually as a result of applying the lessons of research are a great many times the cost."

As well as the obvious savings of time and money that accrue from accident prevention exercises, there is an even more obvious advantage to be gained by simply keeping traffic flowing smoothly, without undue delays. In the past, as Sir William pointed out, decisions affecting expenditure on roads and the action to be taken to meet increased traffic density and complexity, were based on *ad hoc* judgments and opinions formed from limited personal observation. Only through continued and carefully planned research, largely of a statistical nature, are we now in a position to make such decisions on a scientific basis.

HIGH-SPEED TESTS

Built at a cost of £500,000, the new track will be used primarily for research in traffic and safety measures with particular emphasis on vehicle behaviour. Three miles long, it is in the form of a figure of eight with a large paved section in the centre, and contains a number of different test sections and varying types of road surface. There is also a special length of the track designed so that speeds up to 100 m.p.h. can be reached.

Light coloured and dark coloured sections will be used to study the effect of colour of road surface on visibility with headlamps. Provision has also been made for determining the effect of various types of street lighting on the visibility of vehicles, cyclists and pedestrians.

As stated by the Director, the main objects in designing the track were:

1 To provide large flat areas with suitable approach roads to enable the stability of road vehicles performing manoeuvres involving steering, braking and accelerating at normal road speeds to be investigated.
2 To provide facilities for studying the skid properties of wet surfaces, in particular the material and texture used for the surfaces, the effects of the properties of the tyre and the type of vehicle, its speed and braking system.
3 To enable vehicle lighting tests to be carried out on straight and curved roads with surfaces of various types and colours.
4 To enable crash-injury research to be conducted under safe and suitable conditions.
5 To enable comparisons of street lighting systems to be made under controlled conditions.
6 To provide a continuous circuit round which vehicles can be driven while the actions and reactions of their drivers are studied.
7 To provide facilities for traffic tests of intersection layouts, traffic signals, road signs, safety barriers and other aids to traffic flow.
8 To provide facilities for the study of vehicle guidance, and many other matters with which the laboratory is concerned.

The high speed section, which is approached by a banked bend, is covered with typical road surfacings which can be kept wet by means of a built-in watering system, fed from a large supply tank. This permits skidding and braking tests to be made. Tests such as these are becoming more and more necessary as a means of investigating the characteristics of road surfaces and tyres, in order to reduce as much as possible the risk of skidding on wet surfaces at high speeds.

Beneath another section of the track there is a laboratory with a special glass panel let into the surface. Photographic studies can thus be made of the contact areas of tyres as vehicles are driven over it. This facility will help to extend existing knowledge of the behaviour of tyres at the critical point of contact with the road surface and the way in which this affects the skidding resistance of road surfaces. It is hoped that these studies will contribute considerably to the reduction of road accidents due to skidding in wet weather.

The track will also provide means for experiments on the control and guidance of vehicles under fog conditions. Wires laid below the surface will emit signals which can be detected by simple electronic devices in the vehicles. The ultimate objective of this work is to see whether it is practicable to use electronic techniques to assist drivers to steer a safe course through even the thickest fog. Similar electronic devices, using energised wire loops in the track surface, may also be used to warn drivers of vehicles or other obstacles ahead.

JUNCTION STUDIES

The large paved area in the centre of the track will be invaluable for investigations of the layout of road junctions. These will include experiments on traffic signals, trials of new types of vehicle detector and control systems for use at isolated junctions and groups of junctions or at combinations of junctions. Traffic control and the nature of the areas required for the weaving of traffic will also be studied.

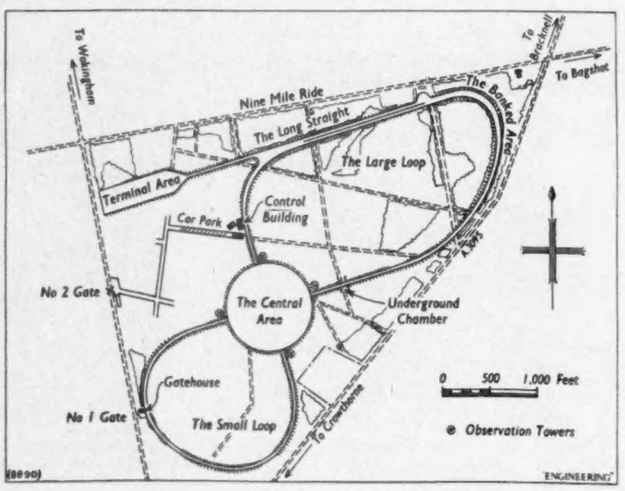
The track was designed jointly by the staff of the Ministry of Works and of the Road Research Laboratory. The figure of eight has a 900 ft diameter centre pan at the intersection, with a straight length of track leading off one of the loops and ending in the skid area. Timber observation towers, adjacent to the four entries of the centre pan, provide facilities for floodlighting and the observation of experimental work on the pan.

After the original design layout had been agreed, the Ministry of Works prepared the detailed design including the shape of the banked bend and its transitions, and the fixed and final levels to balance and fill. To check the designed shape of the banked bend, the Road Research Laboratory set out the bend to scale with Abbott's model apparatus.

The track is of flexible construction, except for the banked bend and a short length of the skid track which are reinforced concrete. It is designed to curve B of the standard design curves using estimated values of the California Bearing Ratio beneath the finished road, based on the soil surveys. Generally, it consists of a granular sub-base of varying thickness, a 6 in cement stabilised gravel base and a 3 in two-coat finishing course of rolled asphalt varied for different sections.

(Left) Wire loops have been laid in the track to facilitate research on vehicle guidance and traffic control.

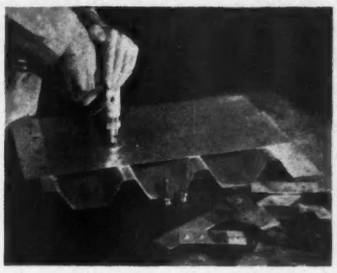
(Right) The track length is three miles, in which a number of sections are of varying road surface.



Simple Welding with Argonarc Torch

A new prototype argonarc spot welding torch, said to be easy to use and cheap to run, has been developed by British Oxygen Gases Limited. Access is required to only one side of the joint to be welded, so that spot welds can be made with only one hand and by a semi-skilled operator. Shear values are said to compare favourably with those obtained with resistance welding.

The torch is water cooled and can carry currents up to 250 amps. It is switched on by a button type microswitch in the handle. The



Access to only one side of the joint is required with this newly developed argon-arc torch.

back entry collet enables the electrode to be replaced or adjusted simply and quickly, without removing the argon shield.

The application of the argonarc spot welding process to stainless steel has recently received approval from the Aeronautical Inspection Directorate. In addition to this, recent development work has indicated that the process can be used on commercially pure aluminium and some aluminium alloys. Mild steel, steel alloys and titanium can also be welded.

Welding conditions are preset, the process is semi-automatic and only occasional changing and resettingtof the tungsten electrode is required. A good surface finish is ensured so that little or no grinding or polishing is required.

Aerodynamics of Rectangular Wings

Lift, drag and pitching moment on a number of model wings, each fitted with a full-span plain flap, have been measured during a series of low-speed wind tunnel tests. The results of this work, plus a smaller programme of hinge-moment measurements, have been given in a report entitled "Aerodynamic Characteristics of Rectangular Wings of Small Aspect Ratio" by I. J. Cambell, C. F. Banks and D. A. Leaver; it is published by HM Stationery Office.

The wings differed from one another in profile but all were of rectangular planform and of aspect ratio 1·25. The flap chord was varied between 0·125 and 0·500 of the overall chord. Three of the profiles investigated were conventional in having zero trailing-edge thickness; but the other three had large trailing-edge thickness, a feature thought to be of interest with the the design of torpedo fins.

Theoretical values of the lift slopes, hinge moments and positions of the centre of pressure were calculated from Lawrence's theory for thin rectangular wings of various aspect ratios in inviscid flow. Predicted values, combining aspect-ratio effects with largely empirical allowances for thickness and boundary layer effects, have been checked against measured values of the required aerodynamic characteristics for the "conventional" profiles, with satisfactory agreement. Although the aspect ratio was small, the induced drag associated with incidence and flap deflection was found to be well represented for all profiles by the usual expression derived from consideration of the elliptically loaded lifting line.

A limited number of measurements suggested that the size of the gap between the control surface and the main part of the wing exercises little influence on the lift slopes, drag and c.p. positions if the gap width is less than 0·5 per cent of the overall chord.

Vacuum Seals with Good Temperature Range

Vacuum tight seals between metal and vitreous or dielectric materials can be made in a number of ways. However, owing to greatly differing coefficients of thermal expansion, the use of such seals is often restricted to a very limited temperature range, in the region of room temperature.

A device has now been developed, at the Services Electronics Research Laboratory, which avoids limitations in the choice of satisfactory materials and enables hermetic seals to be maintained consistently over wide ranges of temperature.

The device was developed principally to meet the high vacuum requirements of the output window seal of an electron discharge tube. Such a seal must withstand high gaseous pressure on one side, while maintaining a low vapour pressure on the other side, in spite of wide changes in temperature.

This new sealing technique, which is the subject of a patent application and is currently being publicised by the National Research Development Corporation, will almost certainly have other applications; for instance, in high-vacuum thermionic valves and in high altitude, high speed aircraft.

Arc Melting and Pouring Furnace

A combined melting and pouring device, for casting small homogeneous ingots of metals and alloys, has been invented at the War Office's Armaments Research and Development Establishment.

The apparatus is said to be particularly suitable for casting samples of alloys of the refractory metals and its use eliminates or reduces the freezing segregation encountered when these are melted and solidified in the same container.

In the furnace, a copper crucible and mould are fixed upon a common axle which can be rotated from a melting position in which the crucible is upright to a second position in which the mould is upright and the crucible tilted for pouring. The axle, which is water cooled, is operated through gearing from a handwheel outside the furnace. The furnace itself may be either evacuated or filled with an inert gas.

Conventional arc heating techniques can be used with the apparatus or an arc may be struck between two independent electrodes above the crucible and deflected on to the charge by a magnetic field. This latter method can be used to melt charges of non-conducting materials. In some cases the charge may be in the form of a consumable electrode.

Powder Weld for Hard Facing

Machine surfaces that are to be subjected to severe working conditions are often hard-faced with a thin layer of wear resistant material. The normal technique of hard facing with welding rods means that layers less than 2 mm cannot be obtained without having to grind the facing itself, after it has been laid. Since the facing is so hard, this grinding operation can be tedious and difficult.

A new method of hard facing in very thin layers has now been developed in Russia, by the Soviet Research Institute for Autogenous Treatment of Metals. Instead of welding rods, this method uses powdered materials such as titanium, nickel, chromium, etc. These are fed on to the component through an oxy-acetylene flame. For this purpose a small conical feed hopper is mounted in the central part of the torch. The powder is conveyed through the flame and deposited on the surface to be hard faced. The rate of feed must be uniform and sufficient to fuse and not to burn the alloying constituents of the powders. This powder feed can be controlled with high precision.

In addition to the advantage of depositing very thin layers, the new method is reported to be rapid and to give deposits of better quality than those obtained with welding rods.

This new technique may mean that many machine parts which have previously been made with expensive alloy steels can now be made with plain steels and subsequently hard faced.

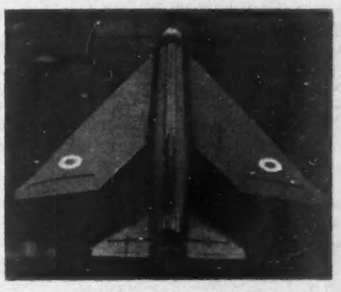
69° Sweep-Back for Research Jet

The Short SB5 adjustable wing aircraft, which was used for all low-speed research for the RAF's Lighting supersonic fighter, recently made a new mark in aviation progress when it flew from the airfield of the Royal Aircraft Establishment, Bedford, with the wings swept back at an angle of 69°. This is a more pronounced continuous sweep-back than that of any other aeroplane in the world.

Taking to the air after only one taxi-ing run, it was airborne for 20 minutes. Observers at the airfield said that in its remarkable new configuration the SB5 "flew like a bird."

The aircraft was designed and built by Short Brothers and Harland to investigate problems of the low speed control of transonic or super sonic wing configurations. The design allows for setting of the mainplanes at three different angles of sweep-back and also for the tailplane to be placed either on top of the fin or below the rear fuselage.

Having made its first flight in December, 1952,



The Short SB5 adjustable-wing aircraft, which was used for research in connection with the RAF's Lightning, has now flown with its wings swept back at 69°.

it has since been extensively tested at 50° and 60° sweep-back, the most suitable configuration suggested by the tests being embodied in the English Electric Lightning swept-back supersonic fighter.

Because of the extra power demanded by the extreme angle of 69° the Rolls-Royce Derwent engine previously fitted has been replaced by a Bristol Orpheus engine. These latest changes of wing and power unit have entailed much more preparatory work in the form of detail drawings and structural modification than was necessary for previous changes of sweep-back.

Lightweight Diesel in a Petrol Tradition

With a high power-to-weight ratio, the new Villiers 4 b.h.p. diesel embodies experience gained in producing many lightweight petrol engines.

ANY company which has to its credit the production of three million petrol engines must have assembled vast experience in design, production and sales.

The Villiers Engineering Company of Marston Road, Wolverhampton, with such a background, have now embarked on the production of a lightweight diesel engine of 269 c.c. capacity. It is air-cooled, has a single-cylinder and is known as the D270.

Operating on a four-stroke cycle, the engine develops 4 b.h.p. at a shaft speed of 3,000 r.p.m. Because of the extensive use of aluminium it weighs only 160 lb which is claimed to be 75 lb lighter than any other British made diesel engine of comparable capacity, giving it a high power-to-weight ratio. It can be applied to a variety of tasks in agriculture, industry and the marine world.

LARGE USE OF ALUMINIUM

Cooling air is drawn through a screen from the engine side of the flywheel housing by a fan which is a centrifugal type, cast integrally with the flywheel. Cooling air passes up to the aluminium cylinder block and cylinder head, and is closely directed by a sheet metal casing over the deep finning on these components. Air for combustion within the engine is also drawn from this supply, the fan acting as a centrifugal pre-cleaner before the air passes through an oil-wash cleaner to the combustion chamber.

The cylinder head, designed in conjunction with Ricardo engineers, includes the Comet III combustion system, which has an inserted heat-resisting alloy hot plug, the top of the chamber being formed directly in the cylinder head material. The piston—which is made of low-expansion alloy—has a recessed crown to suit the combustion system and is of generous section to facilitate heat flow. A chromium-plated compression ring, two taper-faced rings and a slotted oil-control ring are fitted above the gudgeon pin. The gudgeon pin itself is splash lubricated.

A rigidly designed high-grade steel stamping is used for the connecting rod, which is provided with pre-finished, thin-wall, lead-bronze big-end bearing shells for long life. The big-end bearing itself is pressure lubricated through a drilled passage in the crankshaft, in which a sludge trap is incorporated.

Located between two white-metal steel-backed thrust washers is the crankshaft, which conforms to Lloyds specification. The cast-iron flywheel is clamped to the extension of the crankshaft and is fitted with a square key. For certain applications a single-plate clutch can be fitted in a suitable housing to the flywheel end of the engine. The flywheel housing has a machined facing and is sufficiently rigid to allow the close coupling of driven units to this side of the engine if desired, an arrangement which is simplified by the location of the cooling-air intake at the side of the housing.

Crankcase, timing cover, base tank, flywheel housing and cooling-air elbow are all in cast aluminium. The crankcase has been designed to be particularly rigid because into it has been built the high-pressure fuel pump, fuel filter, and lubricating oil filter. Synthetic rubber seals are fitted to both the shaft outlets. Incorporated in the crankcase are drilled lubricating-oil passages and a spring-loaded ball relief oil-pressure valve with an inserted phosphor-bronze seat.

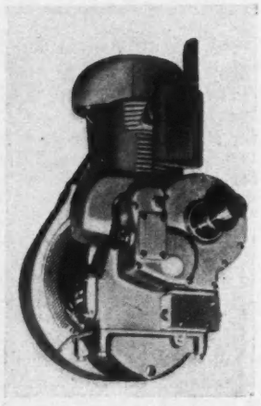
Straight spur gearing drives the camshaft, which is carried on two pressure-lubricated wrapped bushes. The camshaft carries two valve actuating cams and a fuel-pump actuating cam. It also drives a plunger-driven pump which lifts the oil from the base tank though a filter and a series of ball valves to feed it under pressure to a gallery for distribution to the engine parts.

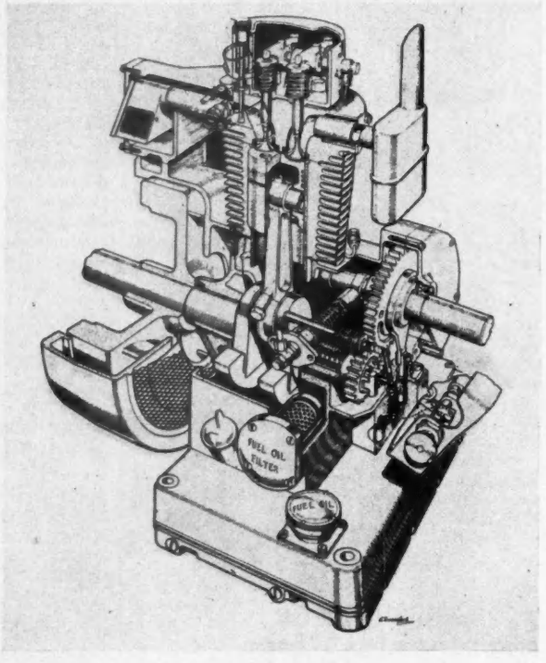
Insulating sleeves are fitted to both the inlet and outlet ports to reduce charge heating and radiation to the cooling air. This helps to prevent carbon deposits being built up within the exhaust port and also ensures that heat is not fed back to the cylinder head.

Fuel oil is stored in a one gallon tank fitted to the base of the engine. Fuel is pumped up to the high-pressure pump by a low-pressure pump, which is camshaft driven. The fuel is pumped through a strainer, fed through ball valves to a Purolator paper-element filter, and thence to a gallery surrounding the high-pressure pump.

(Right) Aluminium is extensively used in the Villiers single-cylinder air-cooled diesel engine thus giving it a high power-to-weight ratio.

(Below) Another version available is this one with a traction type sump. A separate fuel tank reduces the weight by 15 lb, making it a candidate for horticultural machines.





This system eliminates frequent source of annoyance in small diesel engines—the occurance of air locks in the fuel lines whenever the fuel tanks run dry.

C.A.V. Limited of London, W3, developed jointly with Villiers the new fuel injection pump. Known as the " K " type it is somewhat similar to the well known " BPF " type but differs in that it has no housing as such, the pump element being carried horizontally in the engine crankcase casting. The tappet mechanism is also carried in the crankcase, operated from the engine camshaft, and the pump control rod carrying the rack which meshes with the control sleeve is supported transversely in the casting. Fuel enters the pump barrel from a fuel gallery in the pump body, which is fed from a fuel gallery in the pump body, which is fed from a duct drilled in the crankcase. Rotation of the plunger by the control rods alters the effective length of the pumping stroke by bringing the control helix into a different position relative to the spill port. The fuel is carried by banjo connectors up to the nozzle holder, the whole of the pipework being encased within the cooling-air casing.

An interesting feature in the installation of the nozzle is the fact that the nozzle holder is insulated by a washer between its face and the cylinder head to prevent heat transfer to the nozzle. The nozzle itself is of the Pintaux type.

The governor is totally enclosed and operates well within British Standard requirements. The governor weights are carried on the timing-gear wheel which is fitted to the crankshaft. Accuracy of control is given over the " no load/full load " speed change and the " full load " engine speed.

Starting is by means of a detachable handle used on the camshaft extention. Provision is made for cold starting by an oil injection device fitted in the rocker box, ensuring easy starting down to 20° F. An optional extra is a 12 volt electric starter and battery charging dynamo.

To prevent the fuel becoming contaminated in dirty and dusty surroundings, the breather hole has been located on the underside of the filler cap.

Auxiliary equipment is available to suit the engine for a variety of tasks. As it will continue to operate satisfactorily on a tilt in any direction of up to 30° it is obviously suitable as a marine auxiliary.

A traction type sump can be fitted in place of the normal base tank, but this tank holds lubricating oil only and has to be used in conjunction with a separate fuel tank which can be supplied. In this form, however, the engine's weight is reduced by 15 lb and it becomes more suitable for powering horticultural machinery and other similar machines.

A single-plate industrial clutch can be fitted to the flywheel end of the engine.

Crankshaft starting gear is available when the camshaft extension is being used for driving.

When the engine is installed in a confined space the standard cooling case can be replaced by a casing with an adaptor to duct the spent cooling air from the engines. The exhaust pipe can also be taken out coaxially with this ducting.

A variable speed governor is available. This controls the speed and the maximum operating speed of the engine. The control can either be mounted on the engine or arranged for remote operation.

The flywheel drive can be adapted to take 3 : 1 or 6¼ : 1 reduction gear and supplied with or without an industrial clutch.

To meet the needs of operators using the engine under rugged conditions a moulded plastic cover is made.

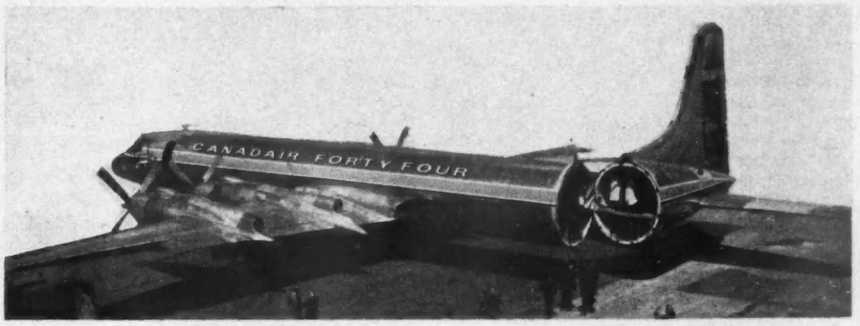
Swing-Tail Transport Gives Quick Turnround

The Forty Four, by Canadair Limited, Montreal, is said to be the first aircraft to have a tail which swings aside to give complete access to the full cross-section of the fuselage. Use of this feature together with a mechanised cargo-handling system (ENGNG., 12 Aug. '60, p. 220) results in a ground turn-around time of 1 hour, compared with about 5 hours for conventional loading. Consequently, the Forty Four can be unloaded and reloaded within the period needed for servicing and refuelling. It will enter service in 1961.

As a freighter, the aircraft has a payload of 33 tons and a transatlantic range. The 136 ft long fuselage is a conventional semi-monocoque structure of aluminium alloy (2024-T3) sheet, riveted to continuous longitudinal stringers and annular frames. The complete tail end of the fuselage, carrying the fin and tailplane, is mounted on two hinges on the right-hand side and opens through an arc of 105°. Streamlined glass fibre fairings cover the hinges.

Two interconnected articulated hydraulic jacks, capable of a 12,000 lb operating force, open or close the tail. They are located in the dorsal, fin. Collet-type locks are incorporated at both ends of the forward jack and at the extended end of the aft jack. The jacks can be locked in either the open or the closed position and a locking sequence ensures that the aft jack will fully extend and internally lock in the opening cycle before fluid is admitted to the extension side of the forward jack. Similarly, in the closing cycle, the forward jack will compress and internally lock before fluid is admitted to the compression side of the aft jack. When fully extended, both jacks are internally locked to act as a fixed strut holding the tail open. The actuating system is designed to open or close the tail against a 30 m.p.h. cross-wind and to hold it open against a 60 m.p.h. wind.

During the closing sequence, alignment between the tail and rear fuselage is obtained by a ramp and roller system. Final alignment is provided by wedge blocks mating with recesses next to each lock. An inflatable seal around the joint faces maintains cabin pressure, and a weather seal prevents entry of rain when the aircraft is on the ground and unpressurised.



The tail of the Forty Four can be swung open on its two hinges against a 30 m.p.h. cross-wind.

The tail and fuselage are secured by 8 locks, of fail-safe design and hydraulically operated. If one lock should fail, the adjacent locks can carry the full loads. In each lock, a tongue fitting mounted in the fuselage locates with a fork fitting in the tail. A lock-pin engages with these and is locked hydraulically: 8 hydraulic actuators have their piston rods directly connected to the sliding lock-pins. Internal mechanical locks, which operate when the actuators are extended, provide a second source of locking-pin security. As a further safety device, ball-locks hold the pins in the extended position.

To avoid chances of unlocking in flight, a manual disconnecting point has been installed in the hydraulic pressure supply line at the swing tail joint to isolate the swing-tail hydraulic system. An indicator in the cockpit shows if the tail is open.

Hydraulic pressure and return lines for the swing tail system and the hydraulic lines for the control surface locks are carried across the fuselage hinge by means of rotating swivel joints. Flexible harnesses and hoses carry electrical power, pneumatic, and fuel lines to the tail.

Controls for the elevator, rudder and elevator trim are disconnected when the tail is opened and are designed so that correct relationships between the pilot's controls and the respective control surfaces are maintained on re-connection. Continuity of the control system is provided by sets of bevel gear boxes which operate pushrods through bell-crank levers. The boxes convert the rotary motion of the control torque-tubes into fore and aft motion across the break line, after which it is converted back into rotary motion by a second set of gearboxes.

Hydraulic pressure for the swinging actuators and the locking actuators is provided by an auxiliary electric pump installed in the fuselage on the left side of the forward underfloor compartment. The pump, which can also provide hydraulic pressure for all hydraulic system functions, has its suction line connected to the main hydraulic system reservoir and its pressure line connected to the system control panel.

Two solenoid-operated valves are mounted on the starboard side of the fuselage next to the joint: one controls the fluid to the swing jacks, the other to the locking actuators. It is in the electrical system controlling the valve solenoids that the sequencing operation is programmed.

Wind Tunnel for the Classroom

To bring supersonics to the classroom, a small wind tunnel capable of gas speeds up to Mach 1·8 has been developed by Plint and Partners Limited, Wargrave, Berkshire. Mr. F. G. Irving, department of aeronautics, Imperial College of Science and Technology, gave advice during its design. The new tunnel was recently demonstrated at Hatfield Technical College to members of the teaching profession.

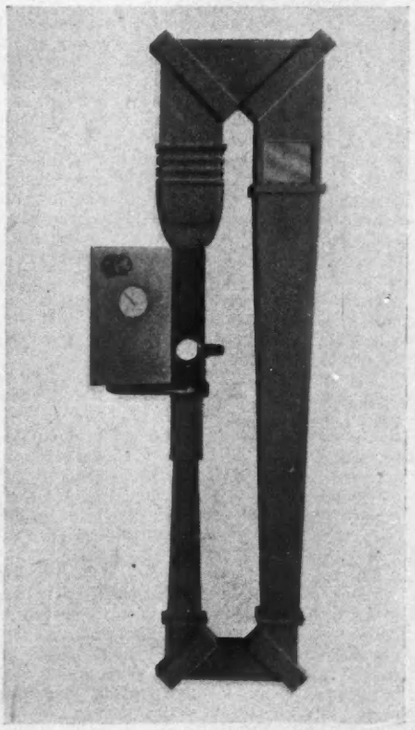
The cross-sectional area of the tunnel has been arranged with the primary object of illustrating two-dimensional phenomena in supersonic flow; for example, the initiation of shock waves. By keeping its size small a moderate price is possible. The induction principle is used—a supply of compressed air is fed to an injector downstream of the working section. A blowing pressure of about 100 lb per sq. in gauge is required at maximum Mach number, and in all cases the pressure in the working section is sub atmospheric.

The tunnel is usually provided with a return duct, as illustrated, but this can be dispensed with where the relative humidity is low and the air blast from the tunnel is not objected to. The tunnel is mounted on a stand which carries the injector air pressure gauge and the control valve.

The cross-section of the working section measures 4 in by 1 in, definition of the flow path calling for a high degree of accuracy in construction. Two liners define the flow path: the bottom one is fixed, the upper is changeable to obtain different Mach numbers. Three liners are supplied, to give a subsonic speed, Mach 1·2, and Mach 1·8; other liners for specific speeds can be provided.

Observation windows of Schlieren glass on each side of the working section are pierced at their centres to provide supports for models. To enable boundary layer observations to be made, a length of each liner surface is visible through the windows. Small diameter tappings at 1 in centres in the bottom liner enable pressure measurements to be made along the length of the working section.

The overall dimensions of the apparatus are 10 ft 2 in long, by 3 ft 7 in high, by 1 ft 3 in wide. Gauzes and a contraction cone inserted before the working section reduce the turbulence of the entering air to a very low level. Air consumption at Mach 1·8 is 1·1 lb per second. A storage vessel of 40 cu. ft is normally supplied and, when charged to 200 lb per sq. in, this gives a running time of about 12 seconds at maximum speed.



The cross-section of this instructional wind tunnel is 4 in by 1 in. Replaceable top liners to the working section provide a range of different Mach numbers.

Greenhouse Glories

HEAT is the heart of the greenhouse. The very fact that the plants are protected from the direct wind or winter cold gives them added life and growth; but if to this is added artificial heat then great things may be expected.

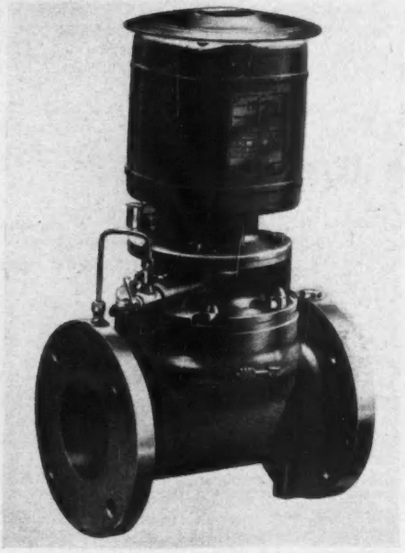
There are as many ways of heating a greenhouse as there are of heating a living house and the same fuels can be used—gas, oil or electricity. The system can be central heating by hot water pipes, soil heating by buried cables or heating by circulating hot air. The choice is there and the type can be selected to suit particular conditions.

For water pipe heating the effect can be improved by using a circulating pump exactly as in small-bore domestic systems. Rhodes, Brydon and Youatt Limited, Reddish Engineering Works, Stockport, Cheshire, make a 4 in MoPump specially for greenhouse work. It is shown in the lower illustration. By circulating the hot water along low level pipes the roots of the plants and the lower trusses of fruit can get their proper share; with natural circulation the greater part goes straight up to the roof. Moreover forced circulation reduces the difficulty of laying out the pipes to give a steady fall through the system.

Different in conception is the Activair system. This has a 20 kW fan heater as the source and the heated air is blown through polythene tubes strategically distributed in the house. By perforating these tubes at suitable intervals the hot air is evenly distributed so that it will reach all corners and give a very even temperature.

(Left) The Plafog is a plastic sprayer made for insecticides.

(Below) A 4 in MoPump will circulate hot water through a greenhouse.



More natural conditions can be simulated by the use of a cycling thermostat. This is designed to give one temperature during the day and a lower one at night. It operates fully automatically, and typical conditions are 65° F during the day and 35° F at night. It is claimed that as a consequence the plants will flourish better than if kept at a constant temperature all the time. The arrangement also reduces the fuel bills.

The Eastern Electricity Board recently installed a system for Burdett and Sons of Whittlesey designed to produce virus-free chrysanthemums. The treatment can be described as accurate heat therapy and is based on findings of the Harpenden research station. A temperature of 97° F is maintained over a period of 21 days to kill off all virus; at this temperature healthy cells will thrive. The temperature is critical, and accurate control is required.

The chrysanthemum cuttings are struck in sand at 60° F in one glasshouse and are then moved to a second glasshouse where the temperature is increased over a period of 72 hours to the required figure of 97° F. In this house elaborate precautions are taken to exclude greenfly, which carry the virus. Cuttings which do not show growth above a certain height during the incubation period are scrapped; the remainder are virus free.

Heating, unfortunately, costs money, so the question of insulation arises immediately. The losses from thin glass can be high but can be reduced by double glazing. Alternatively, sheets of transparent plastic can be used to line the roof and are quite effective. Two points must be watched if this method is used; the plastic must not be finished off so that condensation will drip directly on the plants, and the sealing must not be so good that ventilation is interferred with. Stagnant damp air is a ripe condition for breeding moulds. Double lining also tends to cut down the amount of light available and the loss of light must therefore be balanced against the loss of heat to arrive at the optimum condition for growth—unless, of course, artificial lighting, with or without automatic control, is to be used.

The final touch needed to make the plants spring up is mist propagation. A fully automatic form has been demonstrated and has also been used by the Eastern Electricity Board. It was fitted in the automatic greenhouse of the future exhibited at Ghent earlier this year (ENGNG., vol. 189, p. 636). Control is afforded by a "leaf" consisting of two contacts with a moisture absorbent material between. Current flows between them as long as they are damp, stopping as soon as they become dry. A water valve is then opened and the house sprayed until the moisture content reaches the required figure and current again flows. Soil watering systems can be similarly operated.

Insecticides and other sprays can be delivered to the seedlings by the Plafog shown in the upper illustration. It is a lightweight unit made of high density polyethylene and pressures up to 200 lb per sq. in can be obtained. The container holds half-a-gallon of liquid and is blow-moulded in Rigidex. The pump is the ram type and the spray is forced through a fine nozzle to give good dispersal. The angle bend carrying the nozzle allows it to be rotated so that the spray can be directed up or down, and in the nozzle itself is a stainless steel spray disc with a polyethylene swirl. Full of liquid, the sprayer weighs 7 lb. It is marketed by Cooper, Pegler and Company Limited of Burgess Hill, Sussex.

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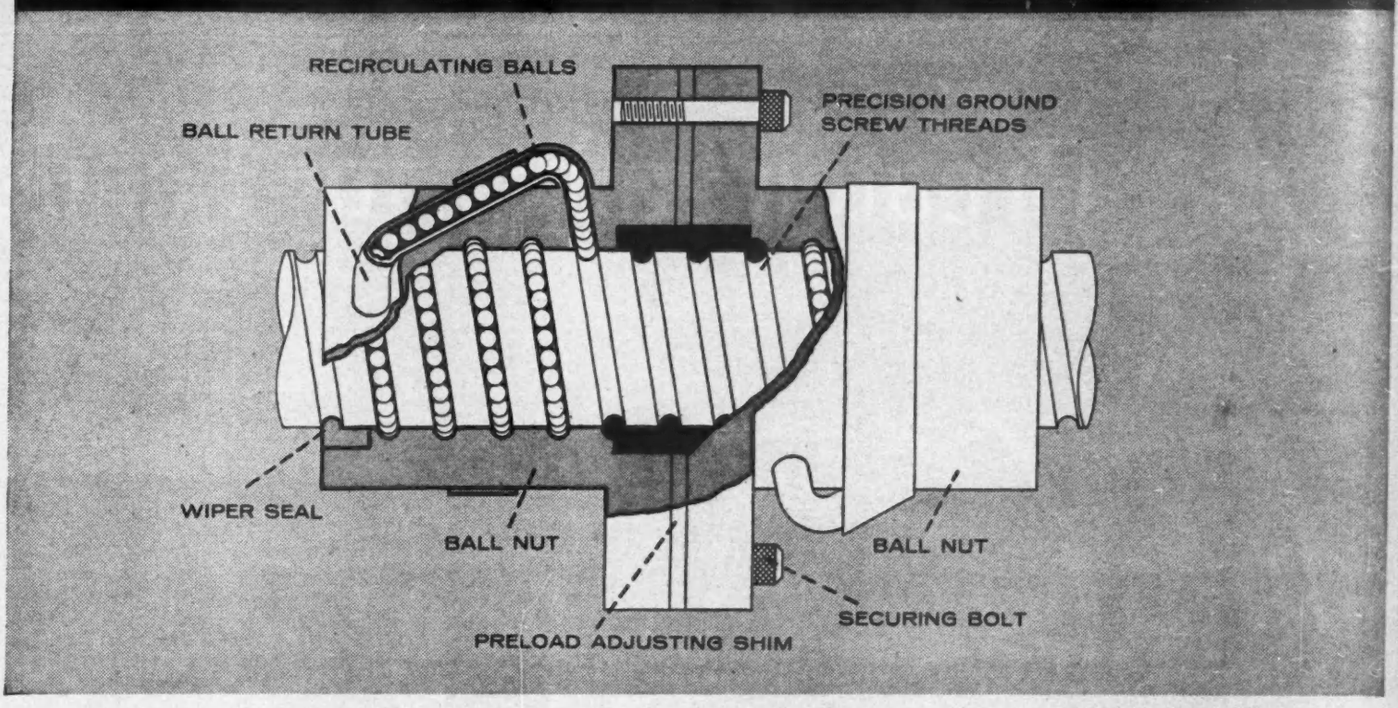

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Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of −52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

J. B. STARKY, SALES MANAGER (BALL SCREWS AND SPLINES), BRISTOL SIDDELEY ENGINES LIMITED, PO BOX 17, COVENTRY, ENGLAND.

BRISTOL SIDDELEY ENGINES LIMITED

ENGINEERING
4 November, 1960 42

Greater safety for hands

With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

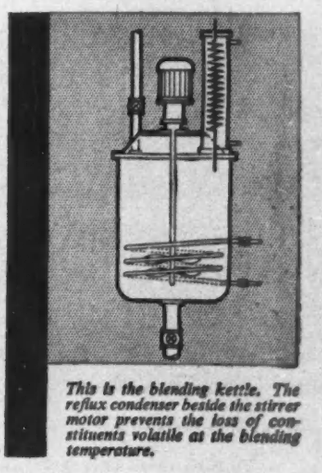
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.



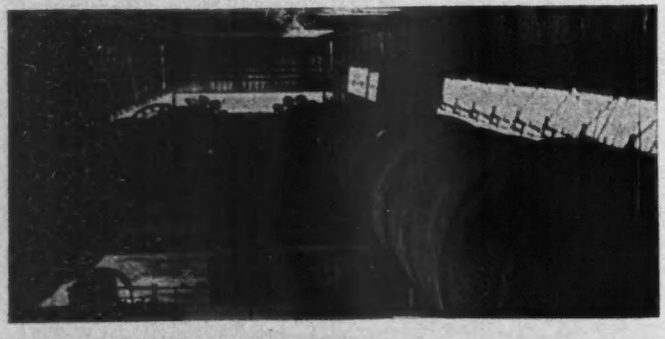
This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

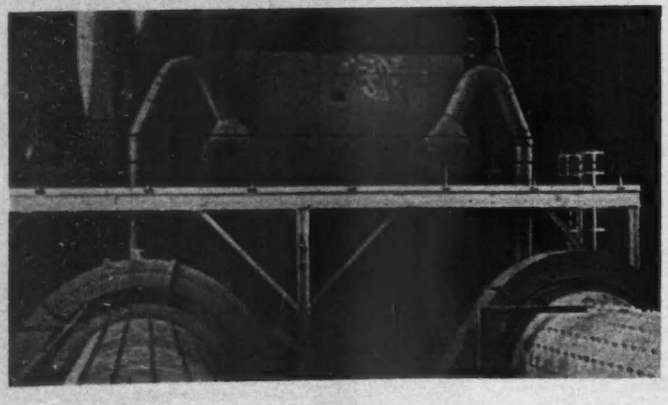
NEW SHELL DROMUS SOLUBLE CUTTING OILS

another proof of Shell leadership in lubrication

New Cement Works in Iran

MECHANICAL PLANT manufactured and erected by EDGAR ALLEN & CO. LIMITED





The area around Doroud in Iran is rich in raw materials, and those for the manufacture of cement lie conveniently close at hand. Here Edgar Allen & Co. Limited have supplied the country's most modern cement plant which has a capacity of 600 tons of Portland Cement per day. By a combination of engineering skill and metallurgical knowledge, we design and manufacture all the machinery for the efficient and economical production of cement from the processing and crushing of raw materials to the despatch of the finished product.

Messrs. Henry Pooley (Consulting Engineers) of London were the Consultants.

Have you had our publication: "Choosing a Cement Plant?"

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To **EDGAR ALLEN & CO. LIMITED - SHEFFIELD 9**

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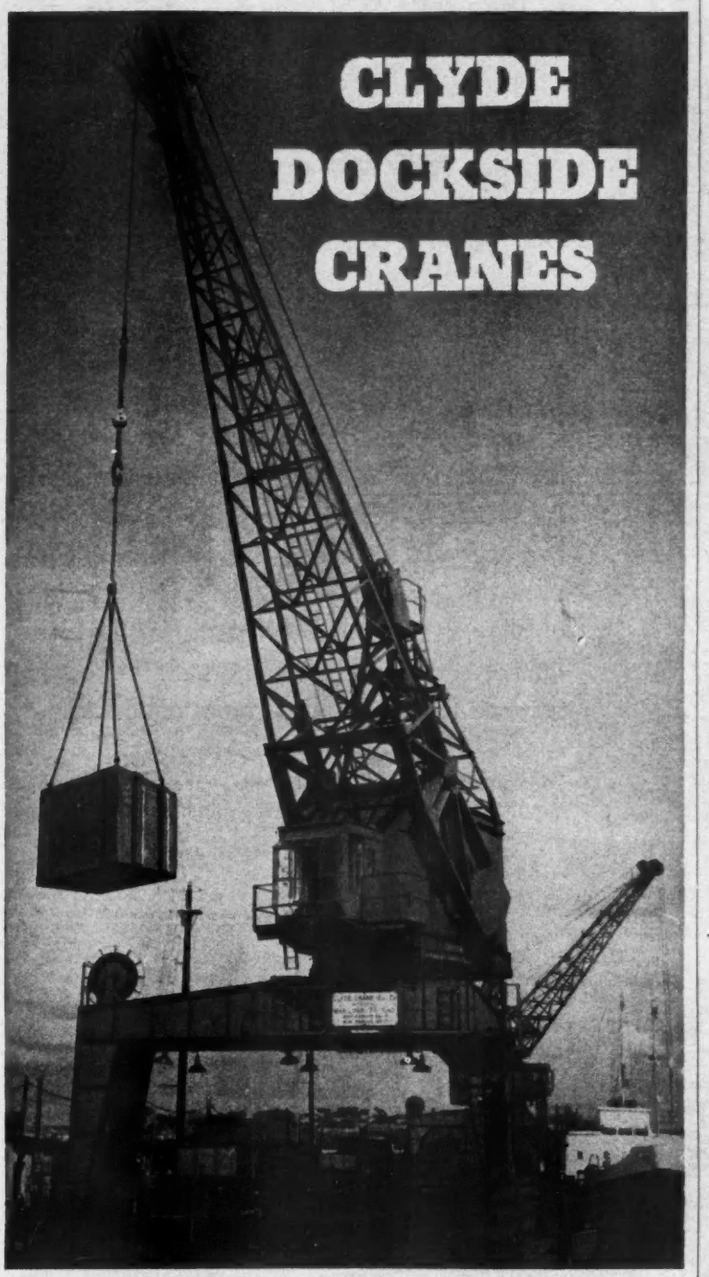

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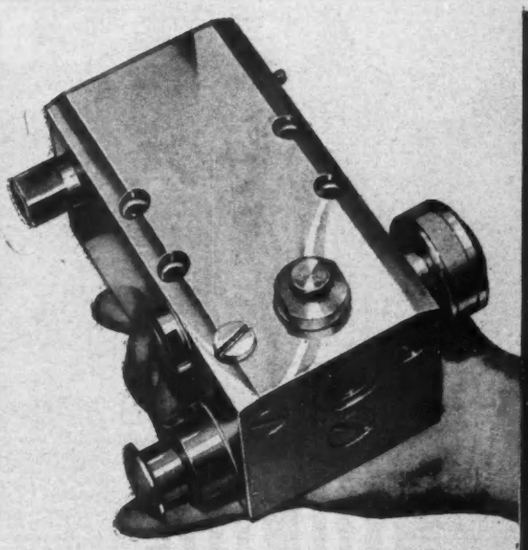

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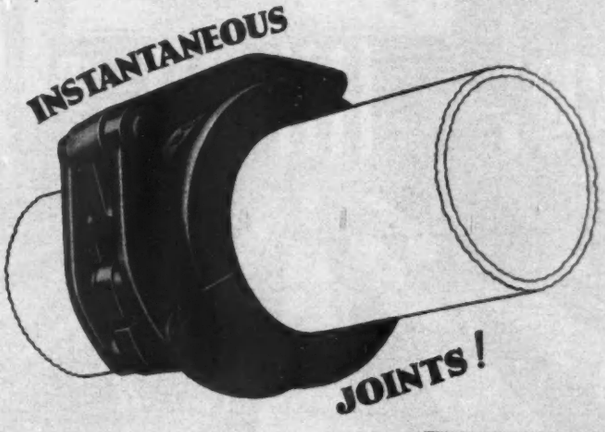

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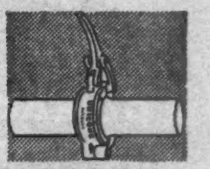
For permanent or semi-permanent pipe lines, 'Unicone' bolted type joints are usually employed and can be assembled far more quickly than any other flexible joint giving positive anchorage.

Rubber gasket in position and joint ready to pull over



Pipe ends joined ready for locking

The joint completed

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leakproof. safe. reliable

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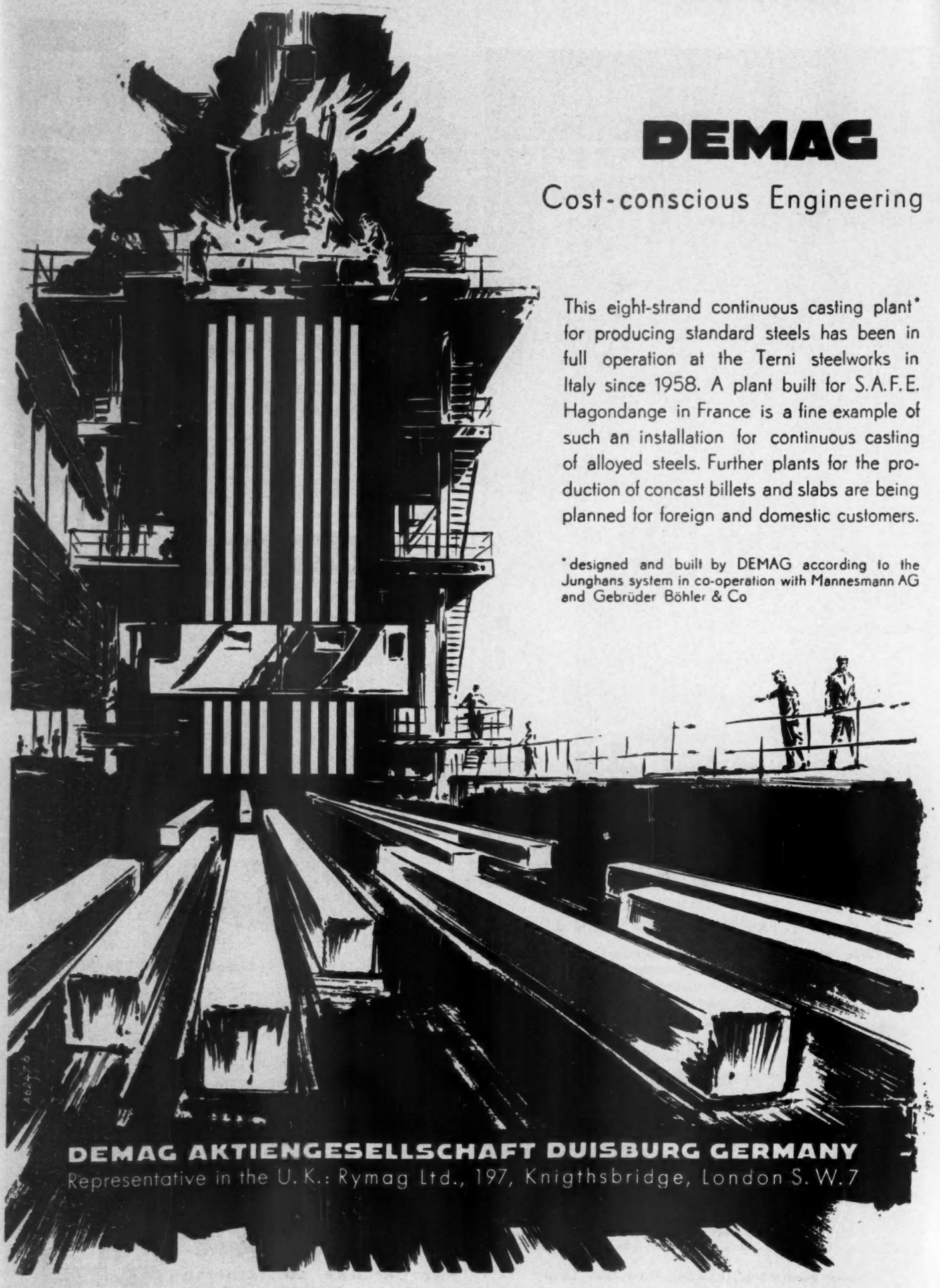

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This eight-strand continuous casting plant* for producing standard steels has been in full operation at the Terni steelworks in Italy since 1958. A plant built for S.A.F.E. Hagondange in France is a fine example of such an installation for continuous casting of alloyed steels. Further plants for the production of concast billets and slabs are being planned for foreign and domestic customers.

*designed and built by DEMAG according to the Junghans system in co-operation with Mannesmann AG and Gebrüder Böhler & Co

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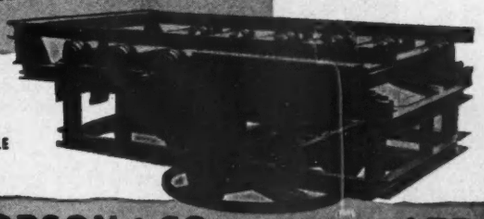

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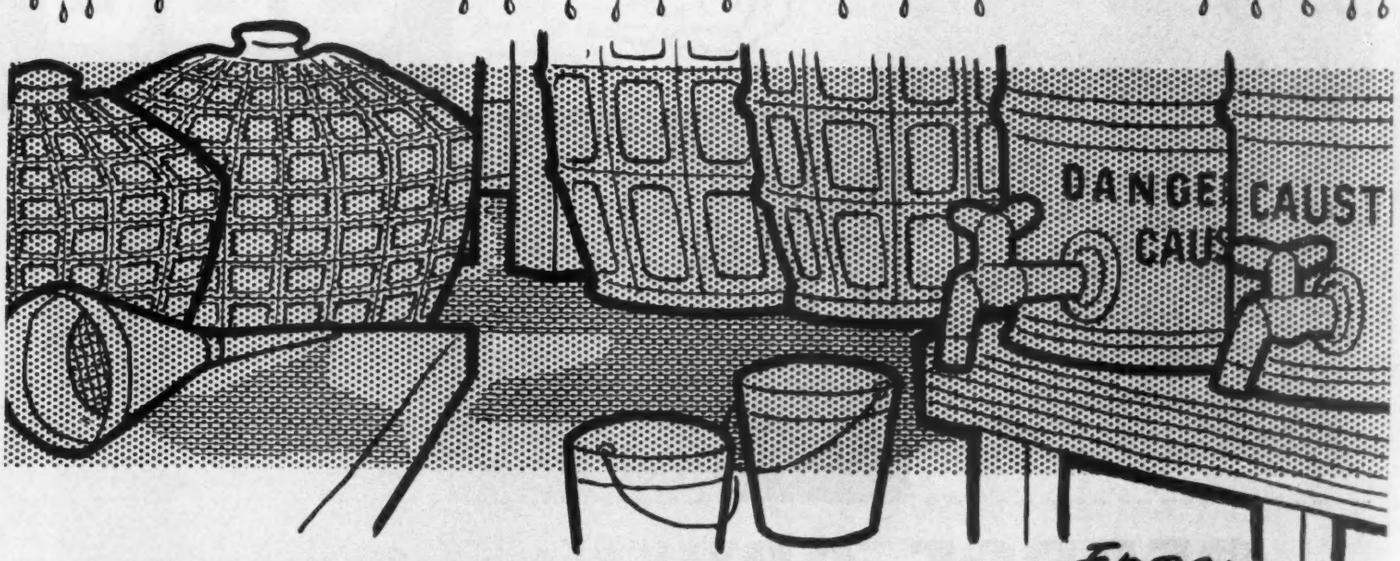

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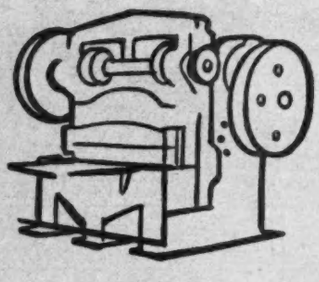

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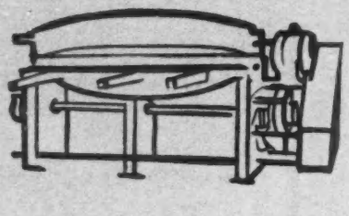

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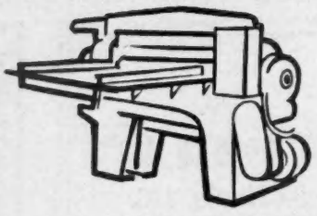

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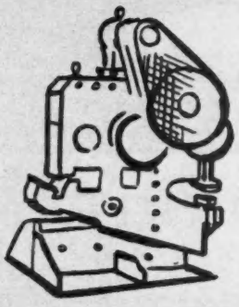

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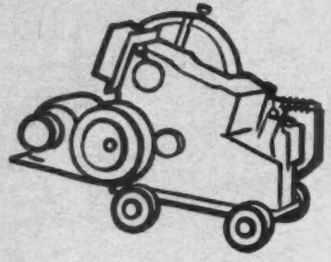

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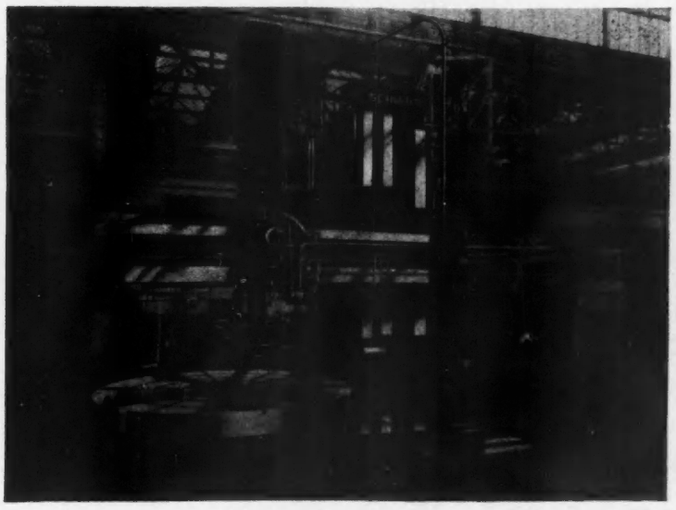
Maximum Turning Height above Table	9 ft. 2 ins.
Table Speed	0.6-50 r.p.m.



Model 4 KE 400/810 Single Column Boring and Turning Mill with fixed column, equipped for slotting.

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Maximum Turning Height	8 ft. 2 ins.
Table Speed	0.7-60 r.p.m.

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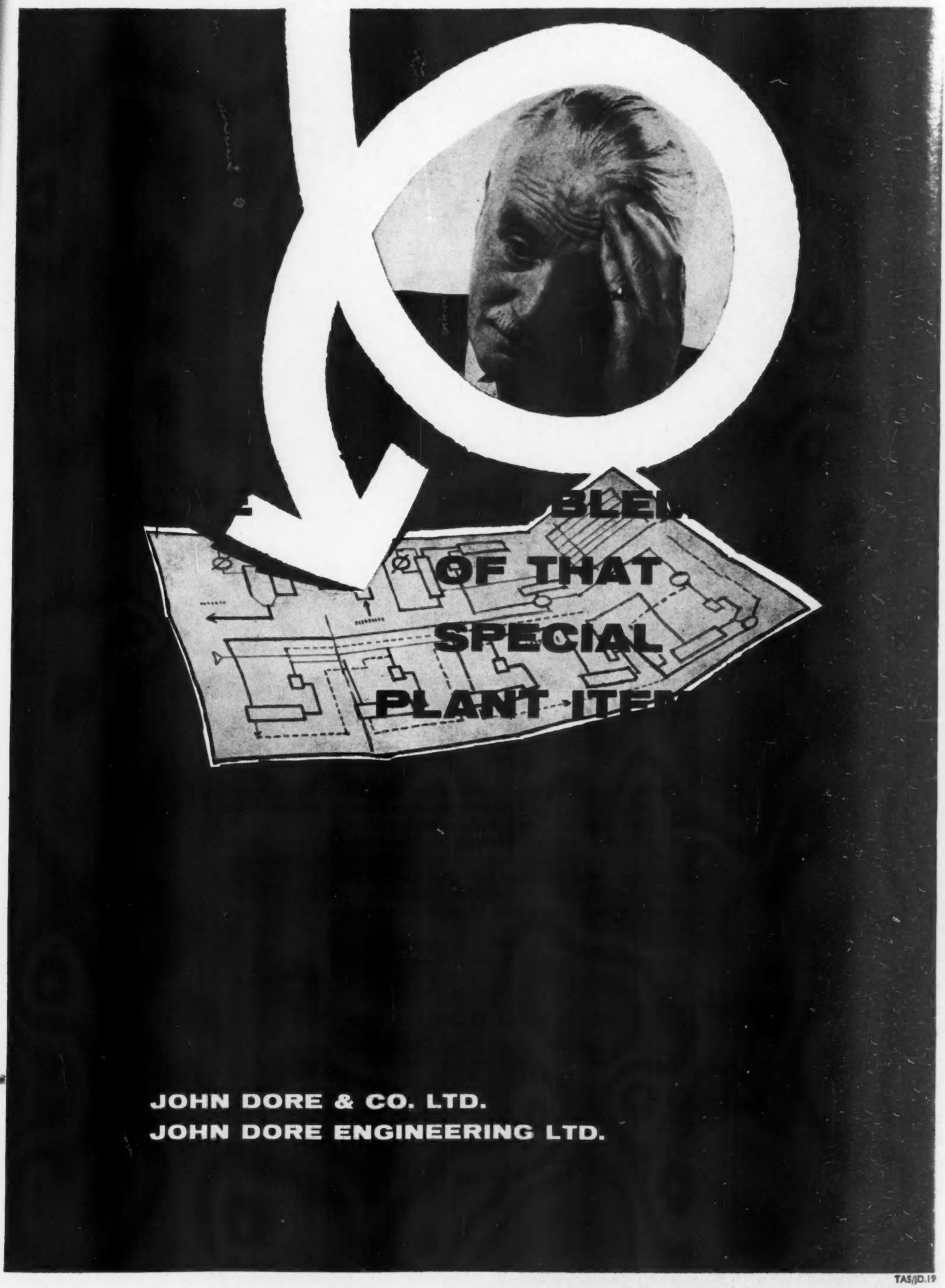
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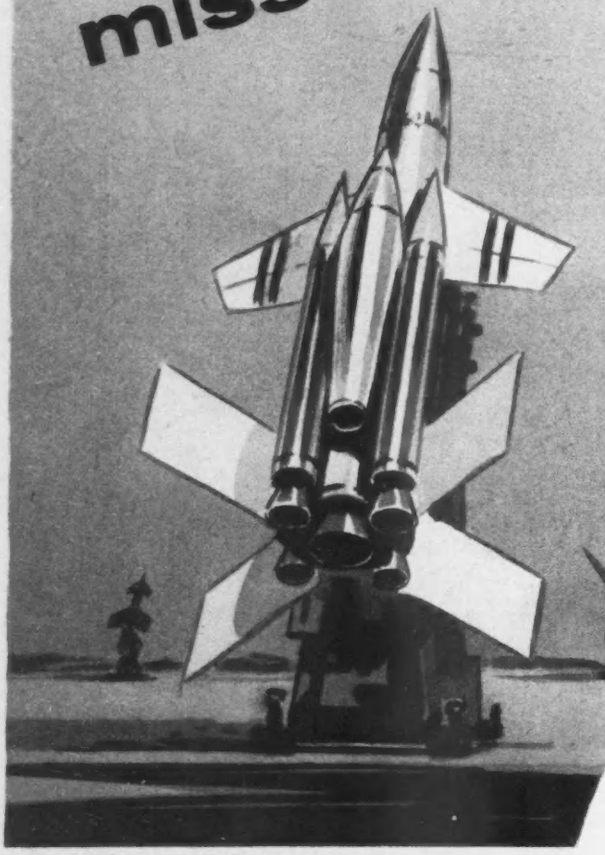

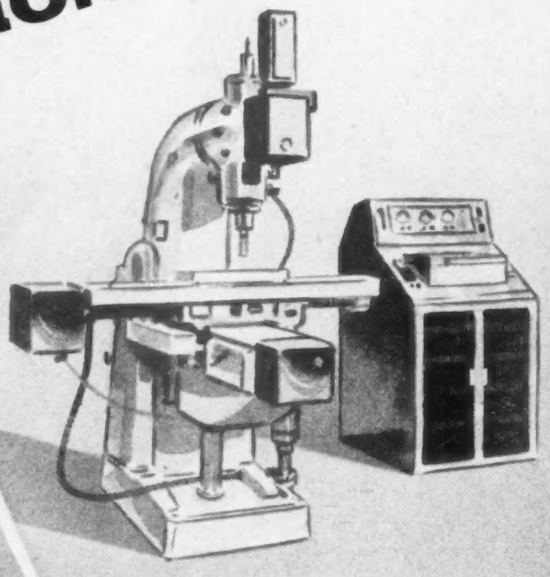

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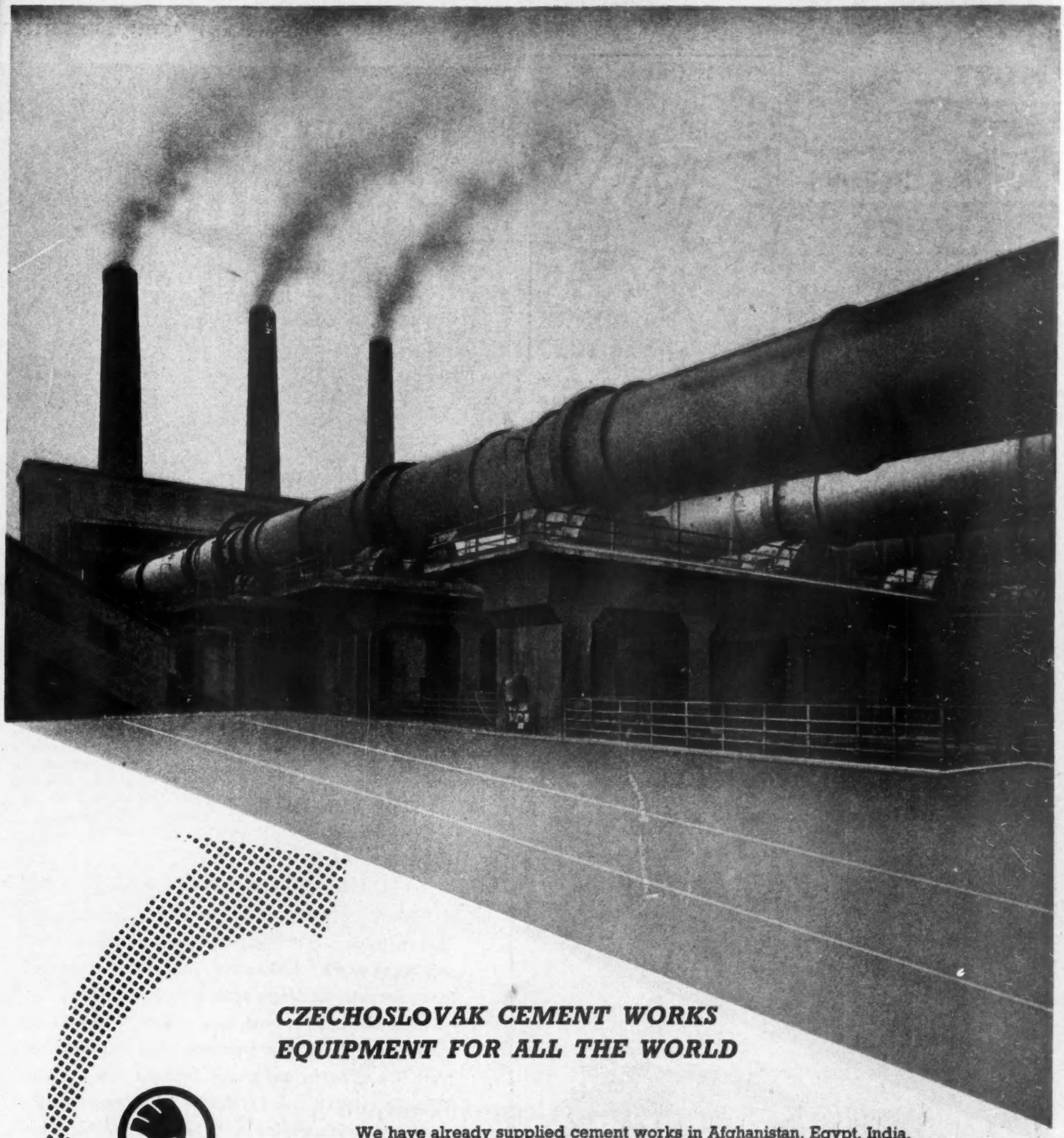

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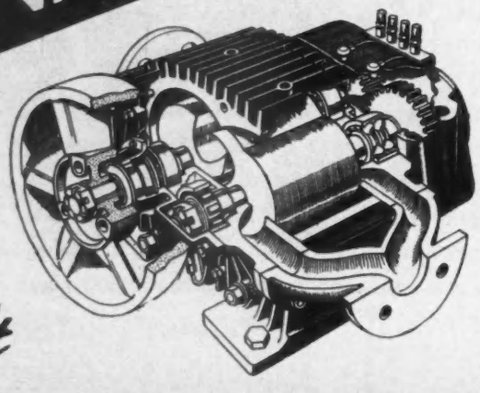

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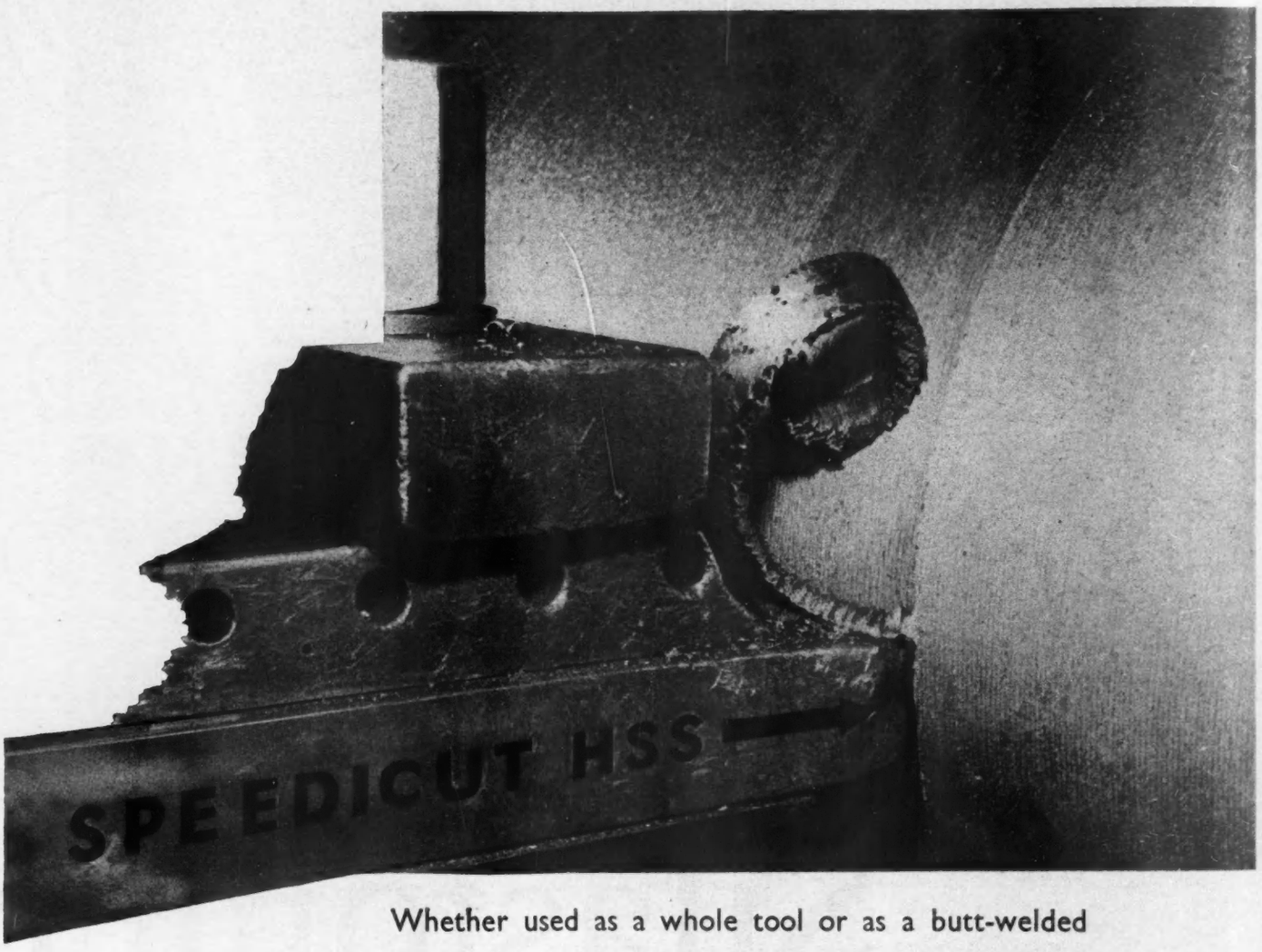

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- *retains excellent dielectric characteristics over a wide temperature range*
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. . . all in all, an impressive list of properties. No wonder, then, that so many rubber manufacturers are producing mechanical mouldings in Silastomer. Get their names and addresses from *any* Midland Silicones branch office.

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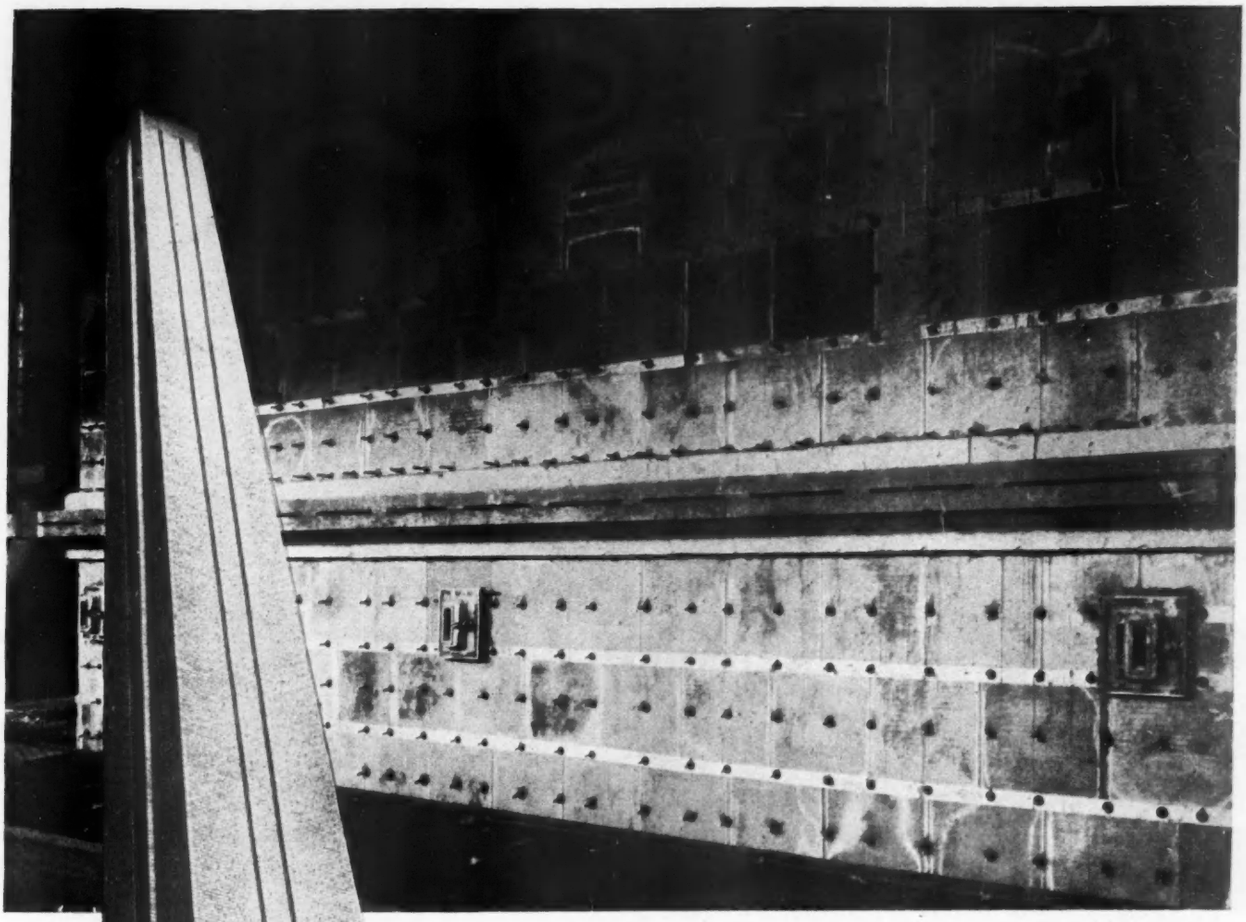

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The illustration shows the refractory cladding applied to a very large power station boiler. In this instance prefabrication was extensively used, and the photograph shows the installation ready to receive the low temperature insulation. This particular system, developed and patented by the R.B.H. GROUP, is now used very widely on modern power station boilers.

R. B. HILTON'S activities range from the refractory and insulation work involved in the largest national and industrial undertakings down to the repair of the smallest self-contained boiler.

A special department deals with chimney construction and maintenance.

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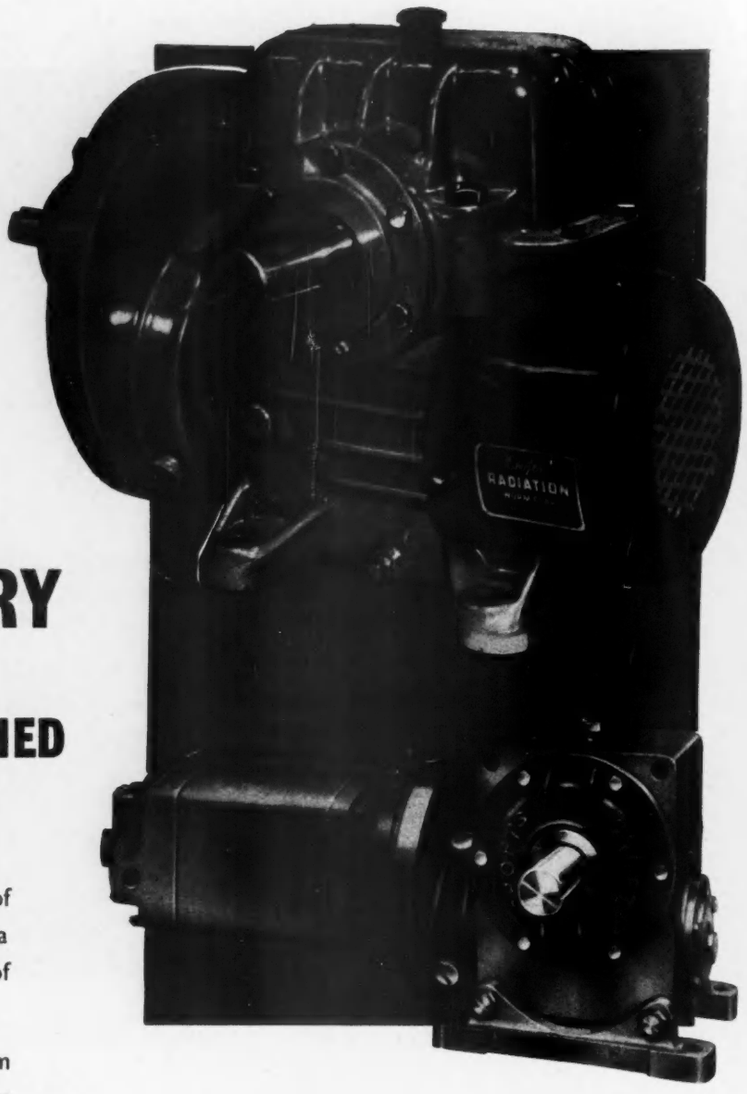


CROFTS 'RADIATION' COMBINED SPUR & WORM GEARS

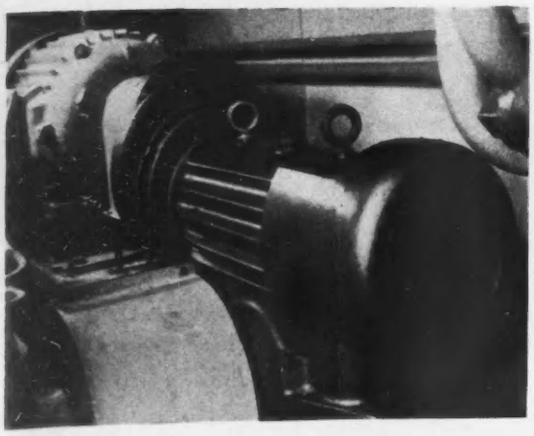
This combination of spur and worm involves a range of stock ratios of reductions from 30 : 1 to 300 : 1 as a right-angle drive, which is a most useful extension of the single Reduction Worm Gear range.

It also provides an alternative to the Double Worm Gears, whilst displaying, in many cases, a greater efficiency than either the Single or Double Reduction types.

This often enables smaller and more economical units to be specified.

The STANDARD RANGE covers units up to 60 h.p. Units up to 20 h.p. are available FROM STOCK. Larger sizes and higher ratios can be made to order. Also available as geared motors.

A Crofts Combined Spur and Worm Reduction Gear installed at a large Plant.



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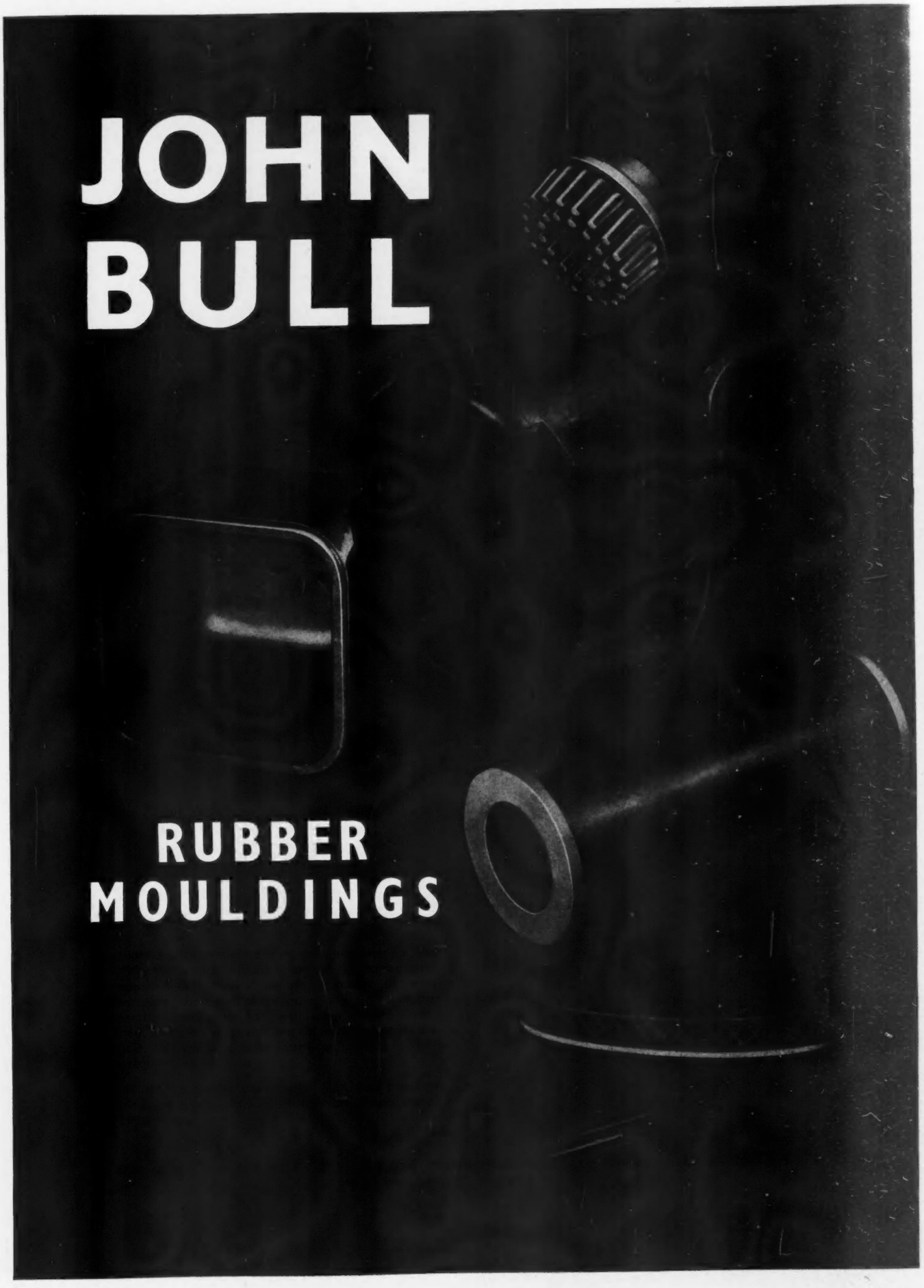
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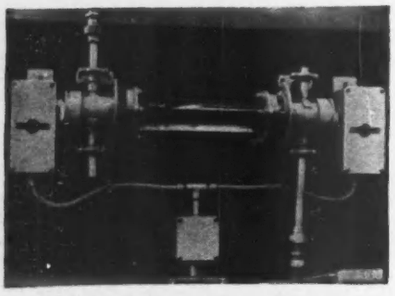
RADIOVISOR EST. 1927

* P.E control

Event Recorder
A permanent record of 'ON' 'OFF' time associated with any process or operation. Idle machine time, duration, over-load periods, etc, are recorded on a 24-hour circular chart revolving at 1" per hour. The recording stylus is operated by a built-in electro-magnetic movement actuated by an external micro switch, relay or other contact-making device.

Electronic Level Control
Radiovisor manufacture many different types of electronic level control so that from their range a unit will be found suitable for any material or liquid. Liquids in tanks, solids in hoppers or powders in packets—there is a level control for the job.



Automatic Turbidity Control
Liquids are continuously observed for clarity and any changes in opacity recorded. In addition to a continuous record, a warning device may be actuated or some other desired function performed if the clarity of the liquid changes to a pre-determined value. The photo-electric viewing chamber may be an integral part of a main feed line, or incorporated into a by-pass sampling system.

There isn't a production plant anywhere that couldn't be made (or hasn't been made) more efficient, more economical by the use of Radiovisor Photo-electric and Electronic Controls

* **P.E** is photo-electric

It costs nothing to consult us—
We have over thirty year's experience

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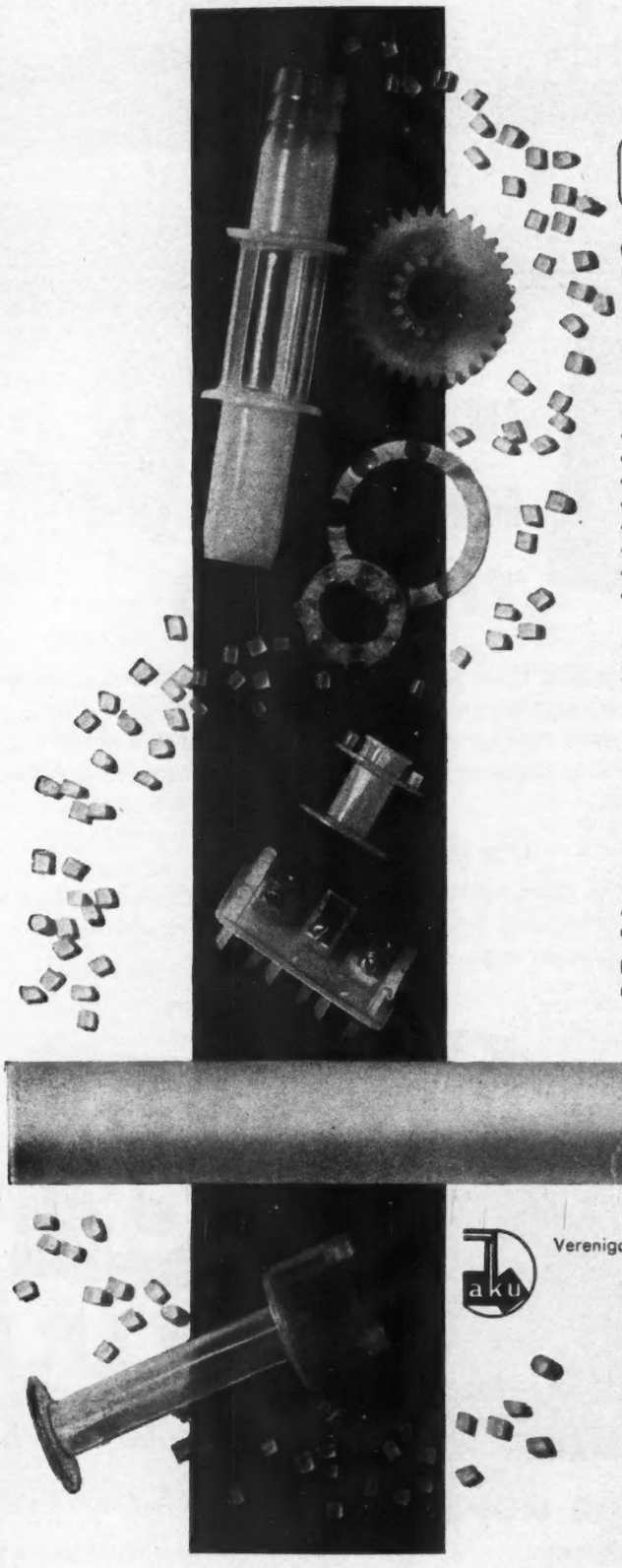

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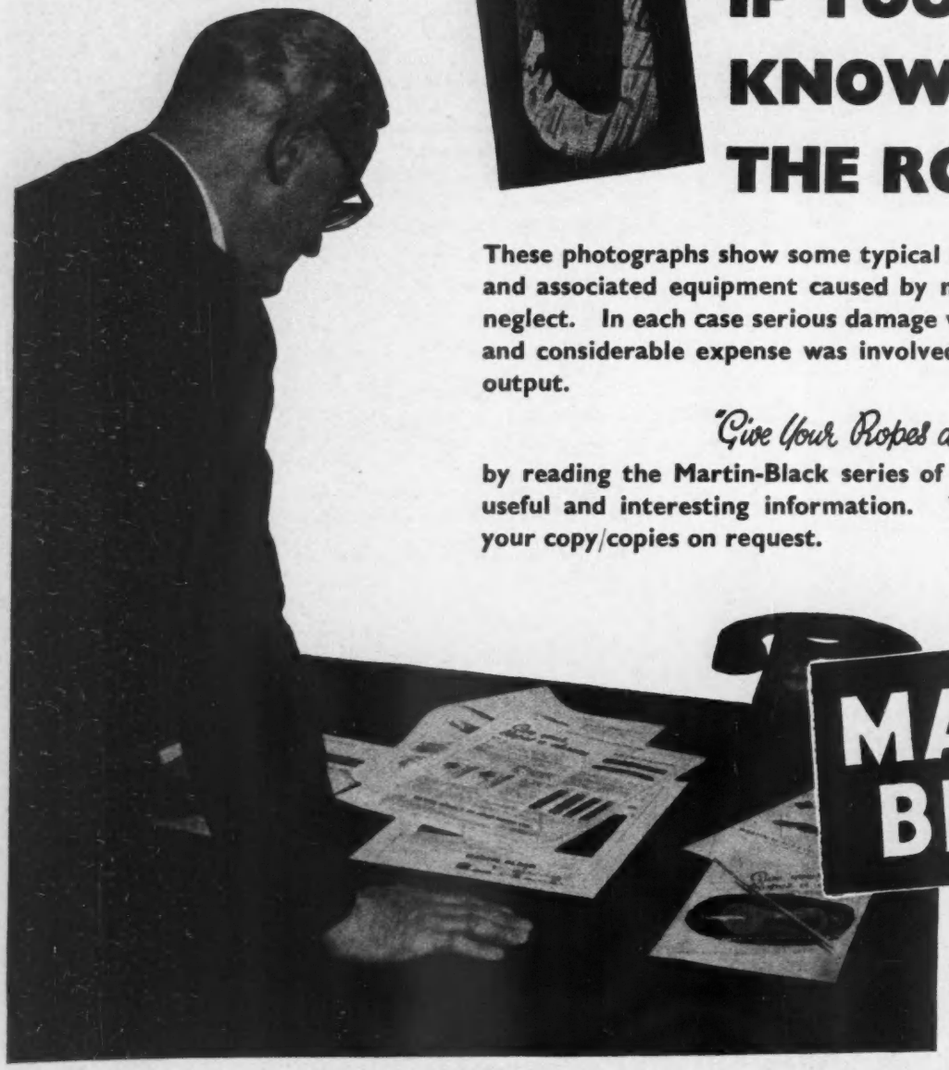

These photographs show some typical instances of damage to ropes and associated equipment caused by mishandling, wrong fitting or neglect. In each case serious damage was caused to the Wire Rope and considerable expense was involved in replacement and loss of output.

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by reading the Martin-Black series of leaflets which contain much useful and interesting information. We will be pleased to send your copy/copies on request.

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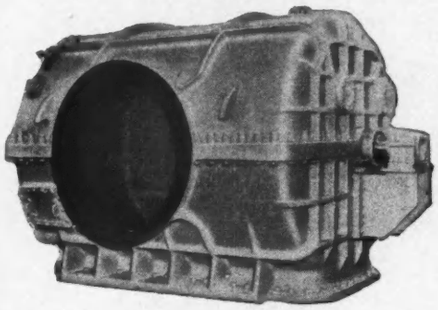

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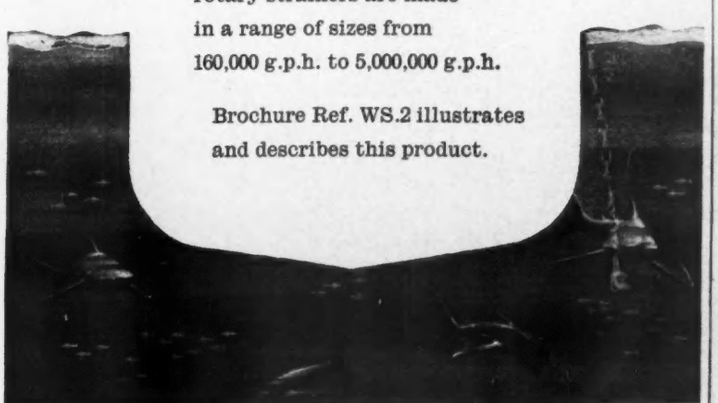
Six Richardsons Westgarth 'Deptford' rotary water strainers strain the condenser cooling water at the Aberthaw Power Station, and are capable of handling 20,000,000 gallons in forty minutes—enough water to float the 'Queen Mary'. The straining is done by a perforated bronze drum; debris collected on the outside is continuously removed by a phosphor bronze scraper blade. Accumulated sludge is discharged from the hopper beneath the strainer without interrupting the flow. Richardsons Westgarth rotary strainers are made in a range of sizes from 160,000 g.p.h. to 5,000,000 g.p.h.

Brochure Ref. WS.2 illustrates and describes this product.



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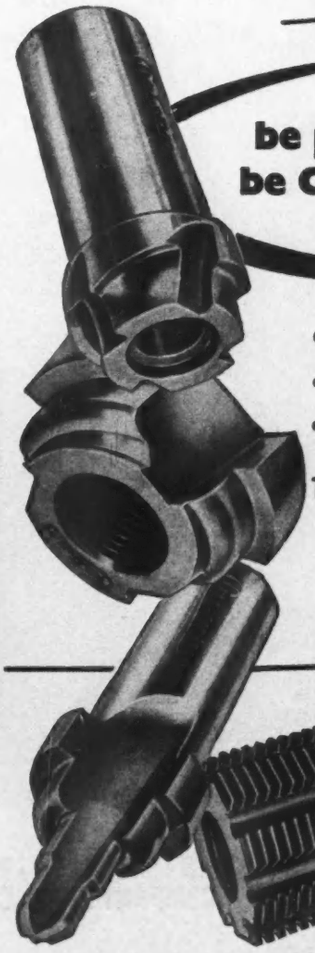

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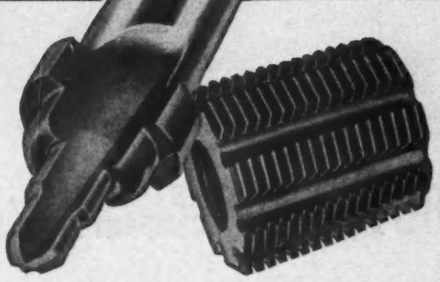

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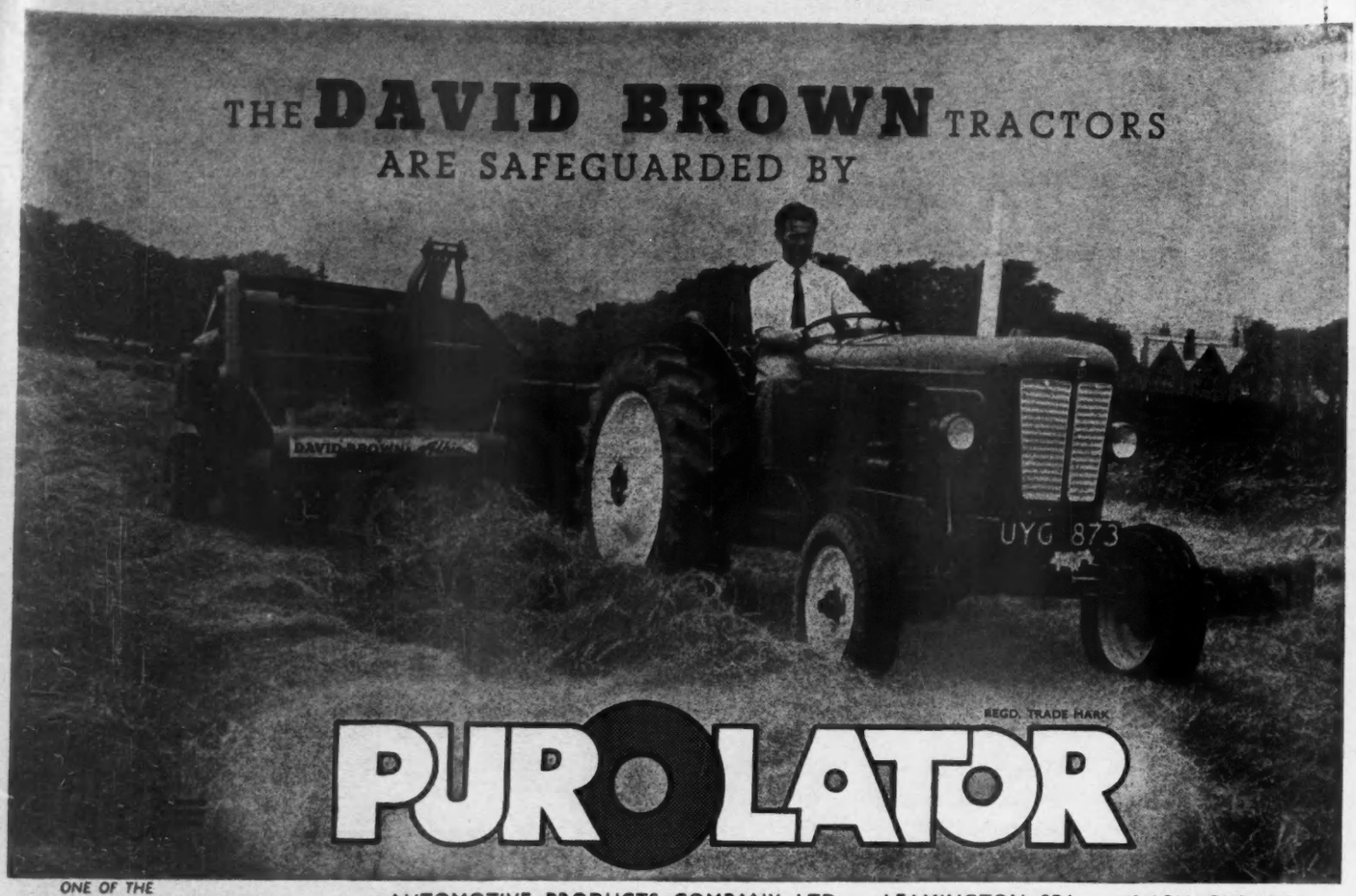

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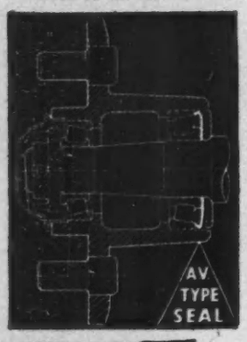

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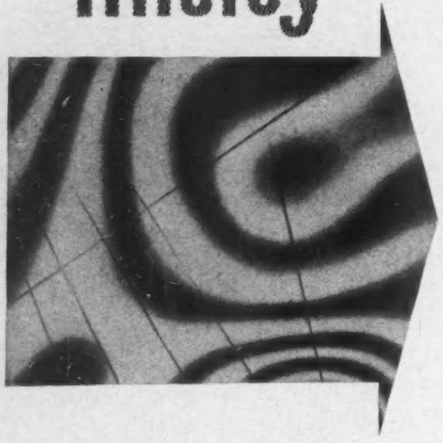

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The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

Tinsley strain gauges are available in various designs and materials to meet individual requirements within three broad temperature ranges:—

Standard strain gauges	**70° C Max.**
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A range of measuring instruments can be supplied for indicating and recording static strains.

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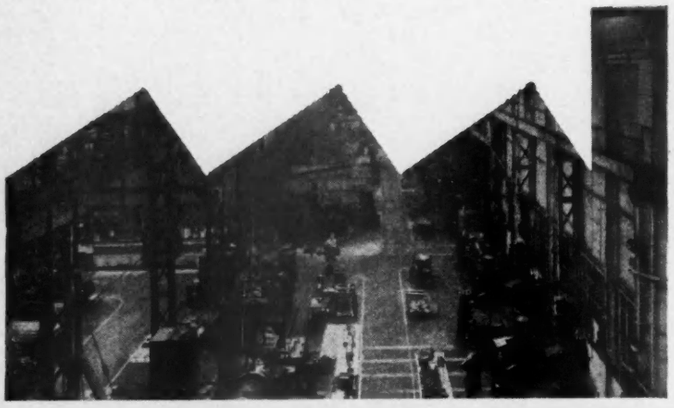

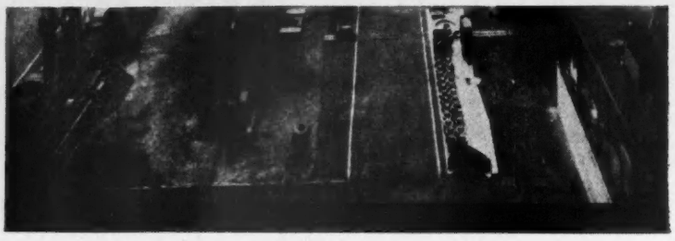

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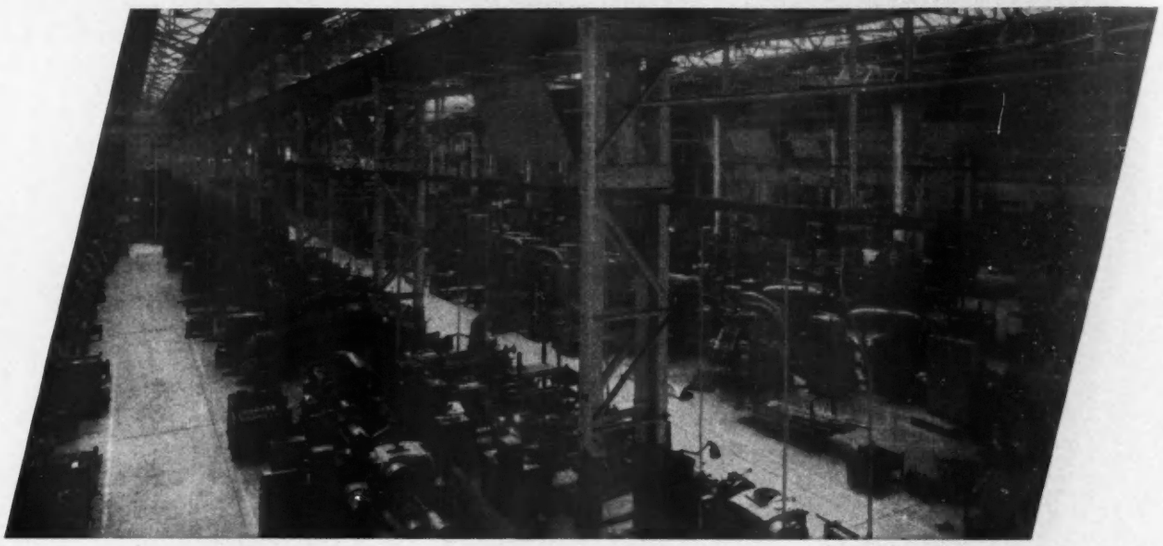

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1000 tons of machinery were re-sited, some machines weighing up to 25 tons. Absolute precision was demanded in the setting of the machines, and the whole job was done out of working hours, at weekends, nights and holiday periods, so that there was no loss of production. This kind of service is worth something these days. You can leave the whole job safely in the hands of WARD'S F.P.I. DEPARTMENT.

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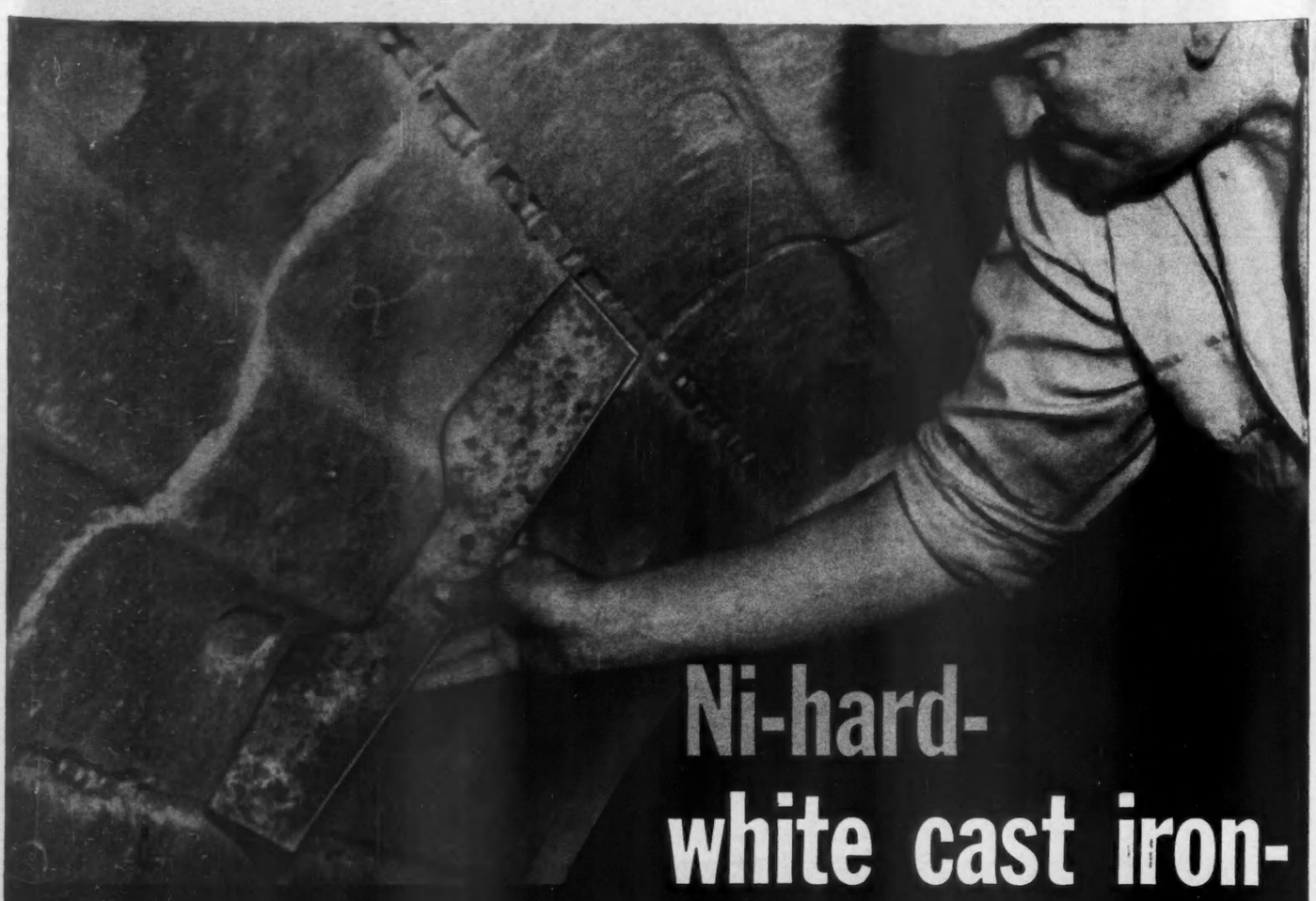
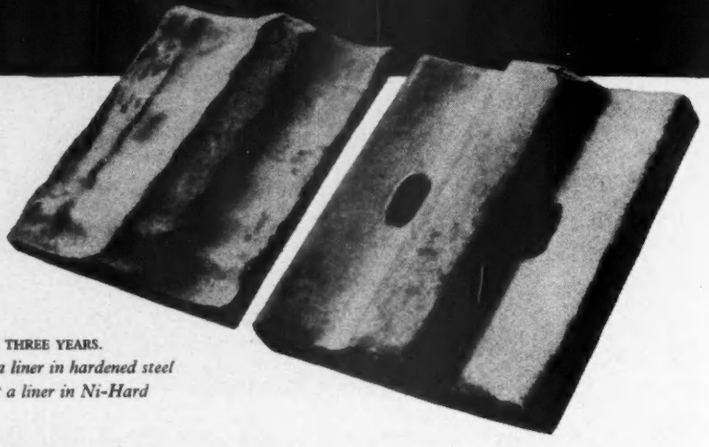


Ni-hard- white cast iron- beats abrasion...

in this dry grinding cement mill



AFTER THREE YEARS.
LEFT *a liner in hardened steel*
RIGHT *a liner in Ni-Hard*

TECHNICAL DETAILS: *Mill internal dia.: 7 feet. Load: 20 tons per hour of dry cement clinker and gypsum. Speed: 71.5% of critical*

FROM SEVEN competitive materials, liners made from Ni-Hard successfully withstood severe conditions, giving promise of up to fifteen years service. Proof of this is shown in photographs by courtesy of Pretoria Portland Cement Co, Union of South Africa, taken after three years' service.

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MOTOGEAR

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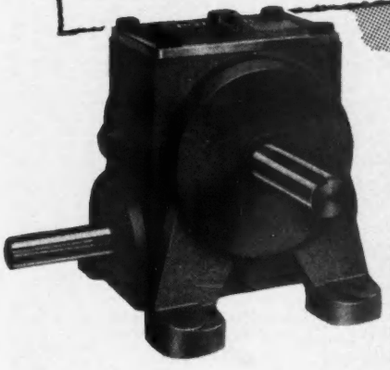

SERIES **J**
WORM REDUCTION GEAR UNITS
UNIVERSAL MOUNTING

Series "J" Units are manufactured in 3 sizes 1⅛", 1¾" and 2⅛" centres with a range of 9 standard ratios for each. They are suitable for fractional horsepower applications and will mount in any desired position.

SERIES **S**
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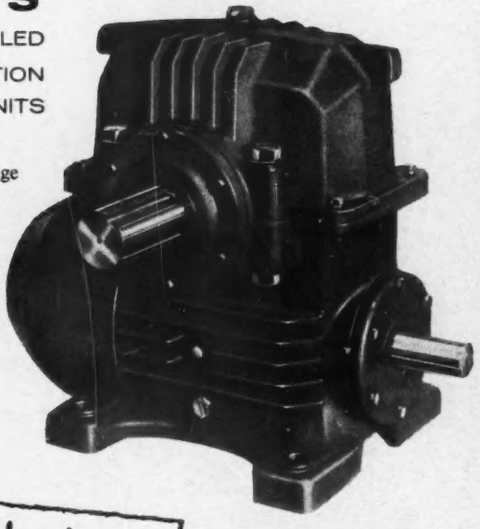
These units are manufactured in a range of 4 sizes and are capable of transmitting up to 30 HP dependent upon the input speed and ratio required



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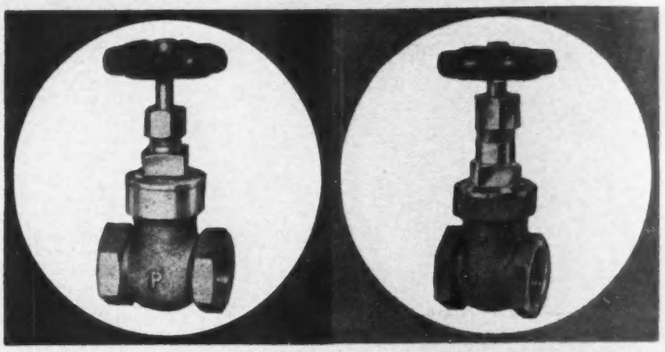
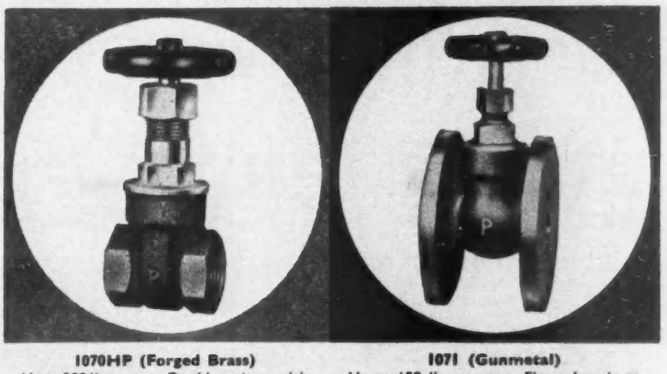
HIGH PRECISION : LOW PRICE



1070 (Gunmetal)
Up to 200 lbs. steam. Round body, non-rising spindle, solid wedge. Sizes ¼"—4".

1070/125 (Gunmetal)
Up to 125 lbs. steam. Hydraulic and oil working pressures up to 200 lbs. P.S.I. Non-shock. Sizes ¼"—4".



1070HP (Forged Brass)
Up to 300 lbs. water. Double action, quick lift, solid wedge. Sizes ¼"—1½".

1071 (Gunmetal)
Up to 150 lbs. steam. Flanged ends to B.S.T.E. Round body, non-rising spindle, solid wedge. ¼"—3". 4" size with bolted cover.

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Handy lever—full operation by a quarter turn. Sizes ¼"—2".

Peglers can supply a very wide range of types and sizes of gunmetal valves in general commercial use at a price made possible only by continuous large scale production.

The Fullway Gate type group, for example, includes valves for most purposes—all fully tested.

★ *Worth noting—"Peglers for all gunmetal valves and cocks on air, water, oil and steam services".*

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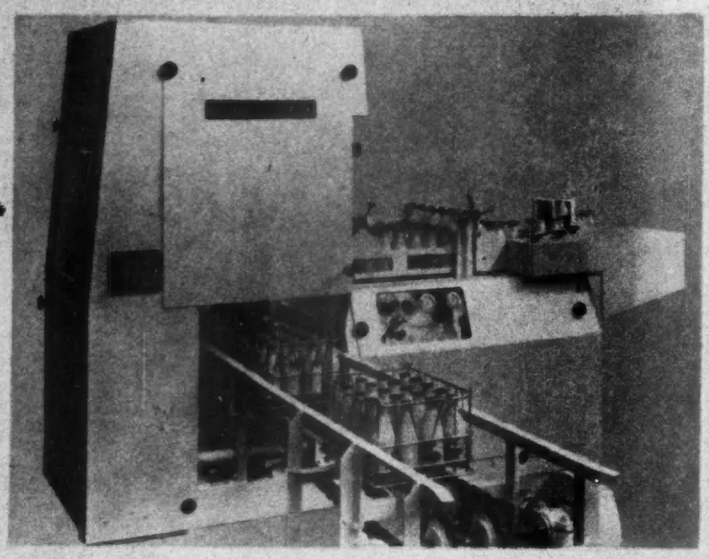

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BY PNEUMATICS, MEANS

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AIR CONTROL VALVES

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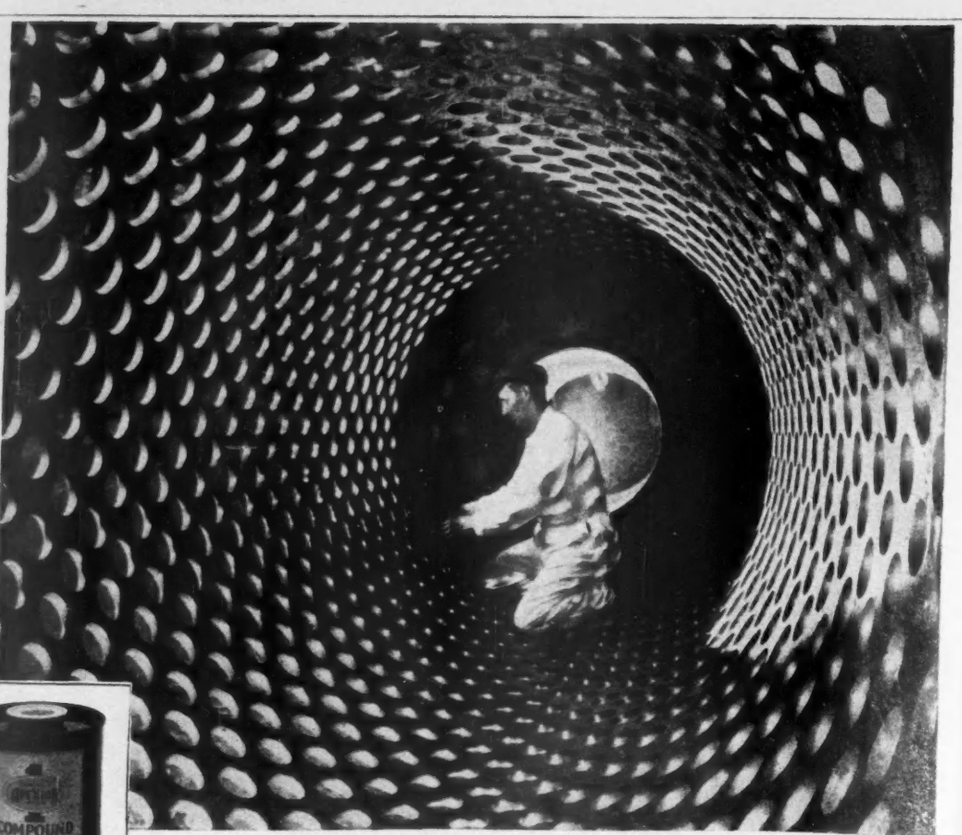
'Apexior No. 1' minimises scale formation, ensures that any scale which does form will be easier to remove; heat transmission is improved and feed water will not be contaminated or discoloured. For full information about 'Apexior No. 1' write today for booklet "Preventing Boiler Corrosion".



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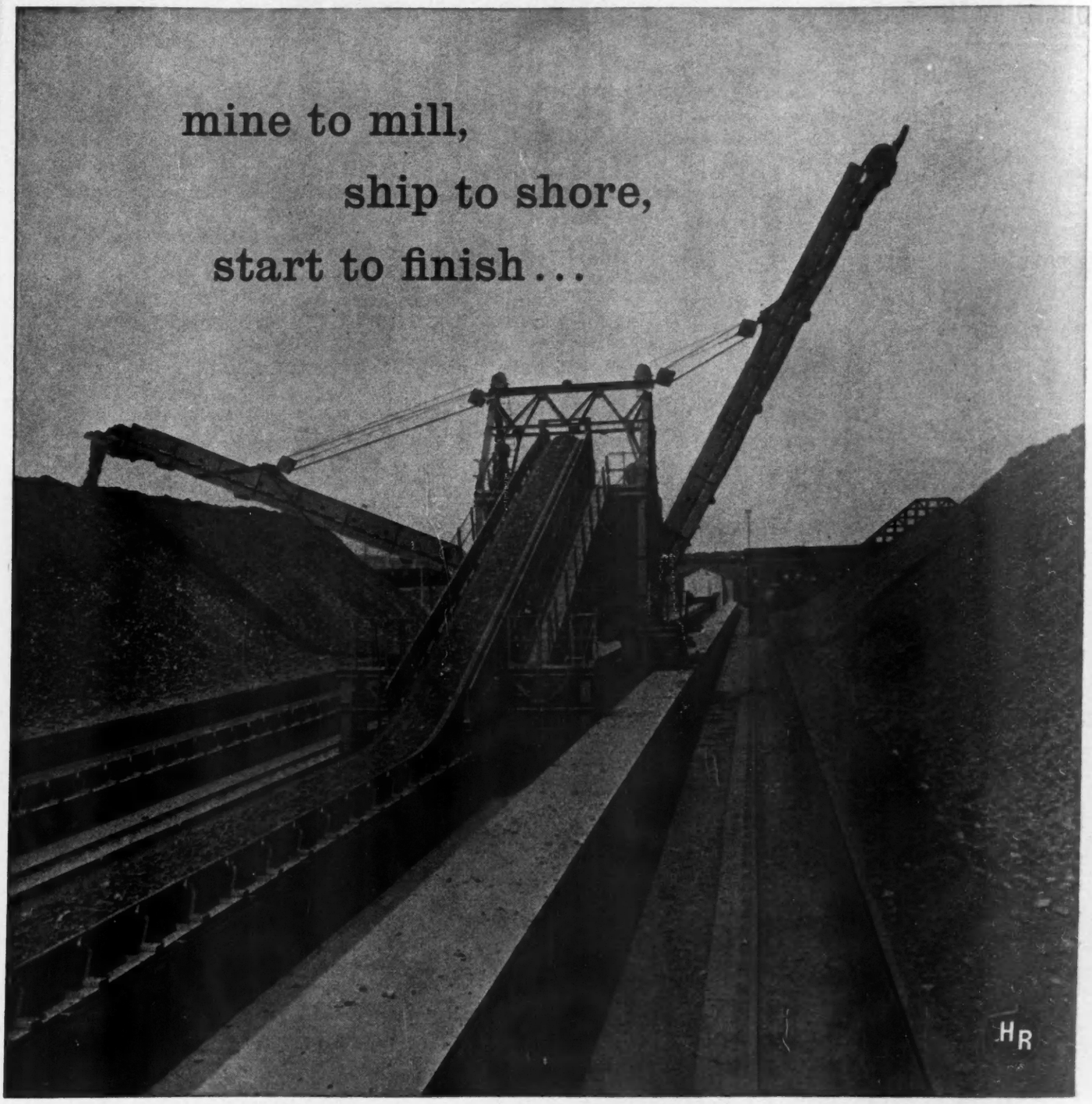

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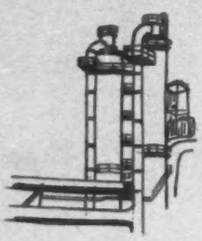

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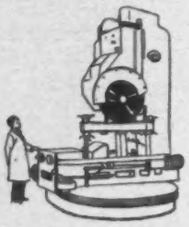

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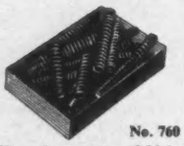

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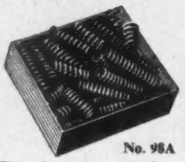

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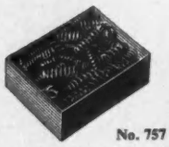

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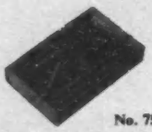

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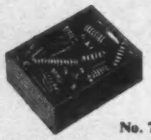

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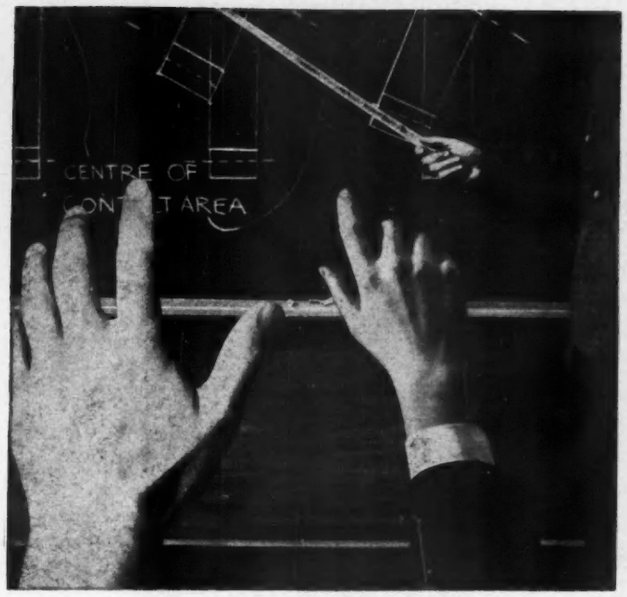

There's talk of Sykes in the Technical Colleges

As the development of production engineering depends on the men it takes and the way it trains them, the machine tool industry is paying ever-growing attention to the subject of recruits and trainees.

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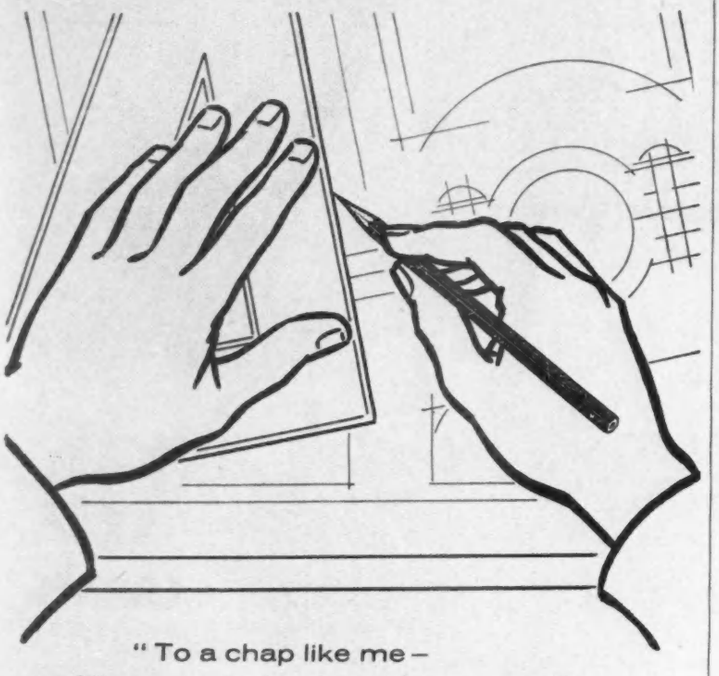

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The pencils I use have to stand up to fast
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be absolutely spot on – not almost
or nearly but bang on the dot every
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The leads must hold their points
and flow smoothly throughout a long line –
no crumbling or 'clinkers' mark you! –
and if I erase a line it must go cleanly –
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made off my drawings. As a matter of
fact you can tell from a print when it is
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"What pencils do I use?"

"Venus drawing pencils of course, the ones
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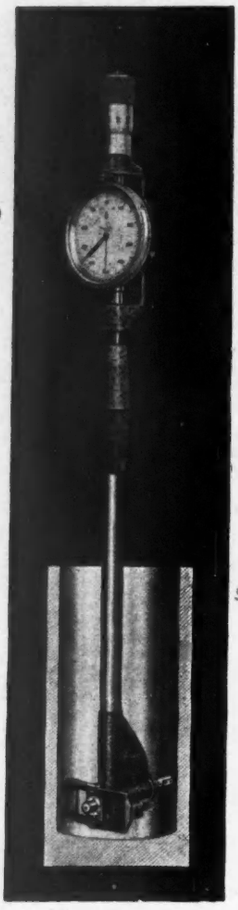

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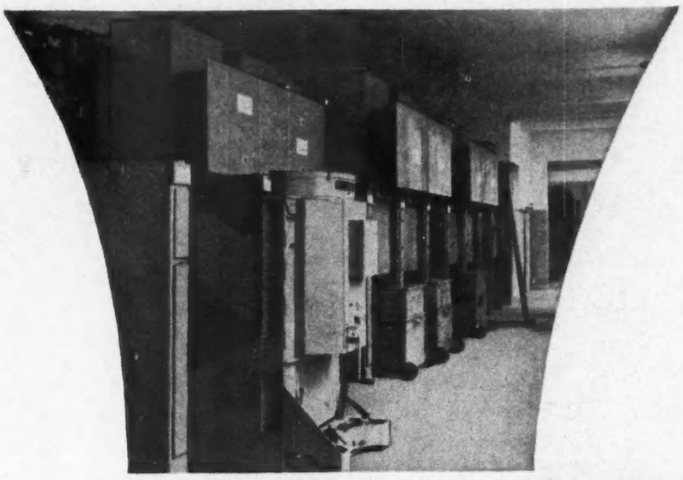
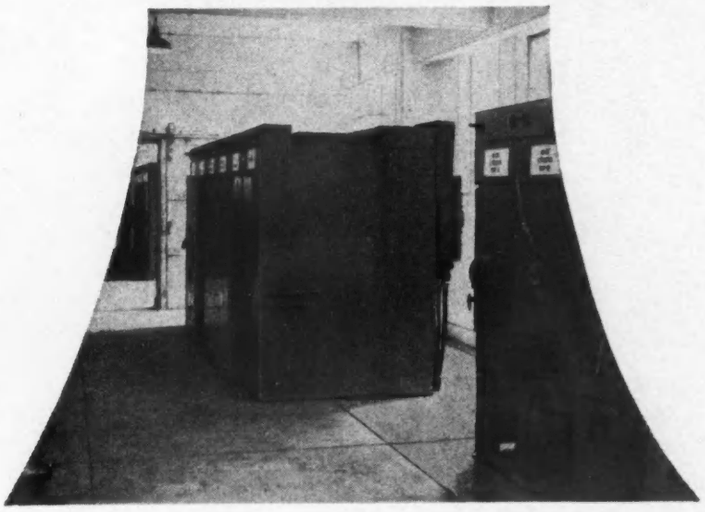


POWER STATION SWITCHGEAR IN SOUTHERN RHODESIA



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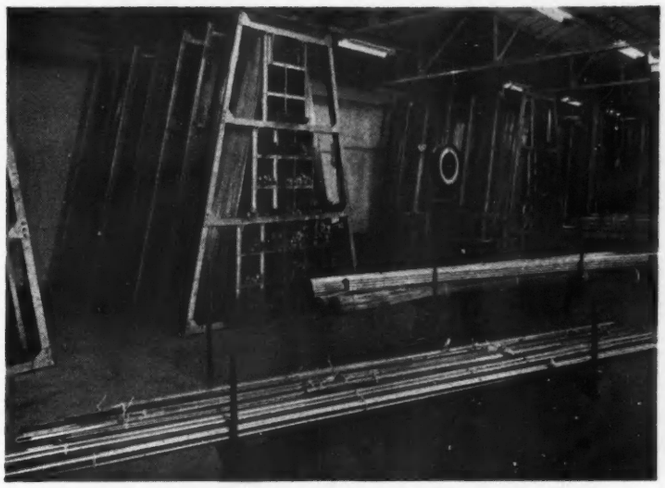

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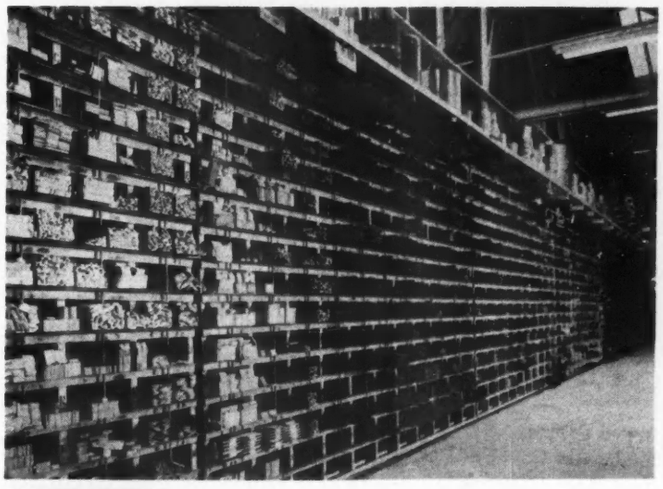

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